United States Department of Agriculture

Forest Service

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Environmental Assessment

Soaproot Restoration Project

High Sierra Ranger District, Sierra National Forest
Fresno County, California

Sections 9, 10, 11, 14, 15, 16, 19, 20, 21, 22, 23, 27, 28, 29, 30, 31, 32, and 33, Township 10 South, Range 25 East; Sections 4, 5, 6, 7, 8, and 9, Township 11 South, Range 25 East; and Sections 24 and 25, Township 10 South, Range 24 East, Mount Diablo Meridian

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1.0. Purpose and Need for Action

1.1. Introduction

The High Sierra Ranger District (HSRD), Sierra National Forest (SNF) has prepared this Environmental Assessment (EA) for the Soaproot Restoration Project (Project) in compliance with the National Environmental Policy Act (NEPA) and other relevant federal and state laws and regulations. The Project is being proposed under the Healthy Forests Restoration Act (HFRA) of 2003[1] authority. The Project involves a variety of restoration treatments to reduce hazardous fuels and restore ecological components within the landscape.

There have been a few modifications to the proposed action relevant to the EA since Project scoping was conducted in June of 2011 (see Section 1.7). The Project has been more refined since scoping. Consequently, the analysis is based on more detailed and specific data and information. The Project was originally scoped with 7,120 acres, whereas the analysis only covers 6,958 acres. Existing and desired conditions and the purpose and need for the Project include more detail than was included in the scoping document. Changes to the proposed action are described in alternative 2 (see Section 2.1.2).

This EA discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action and alternatives. It also provides the supporting information for a determination to prepare either an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI).

Additional documentation, including more detailed analyses of resources in the Project area, may be found in the Project planning record located at the HSRD office in Prather, California.

1.1.1. Location

The Project area includes 6,958 acres of the SNF in the southern Sierra Nevada Mountains, approximately 30 miles northeast of Fresno, California (see Figure 1). The legal description is: Township 10 South, Range 25 East, Sections 9 – 11, 14 – 16, 19 – 23, and 27 – 33; Township 11 South, Range 25 East, Sections 4 – 9; and Township 10 South, Range 24 East, Sections 24 and 25, Mount Diablo Baseline & Meridian Township. The area ranges in elevation from 2,800 to 6,000 feet. The Project area is located in the Soaproot management unit (Soaproot Unit) and covers the area northeast of Cherry Flat and southwest of Grand Bluffs which includes the Rush Creek and Providence Creek drainages and the Blue Canyon area.

The Project is located primarily in the Wildland Urban Intermix (WUI)[2]. This zone is an area where human habitation is mixed with areas of flammable wildland vegetation that extends out from private developed land into land under private, state, and federal jurisdictions. Nearby communities include Shaver Lake, Ockenden, Pineridge, Cressmans, and Dinkey Creek.

[1] (Public Law 108-148)A copy of this act is available at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=108_cong_bills&docid=f:h1904enr.txt.pdf
[2] See Section 3.1.1.1 for more detail on the WUI within and adjacent to the Project area.

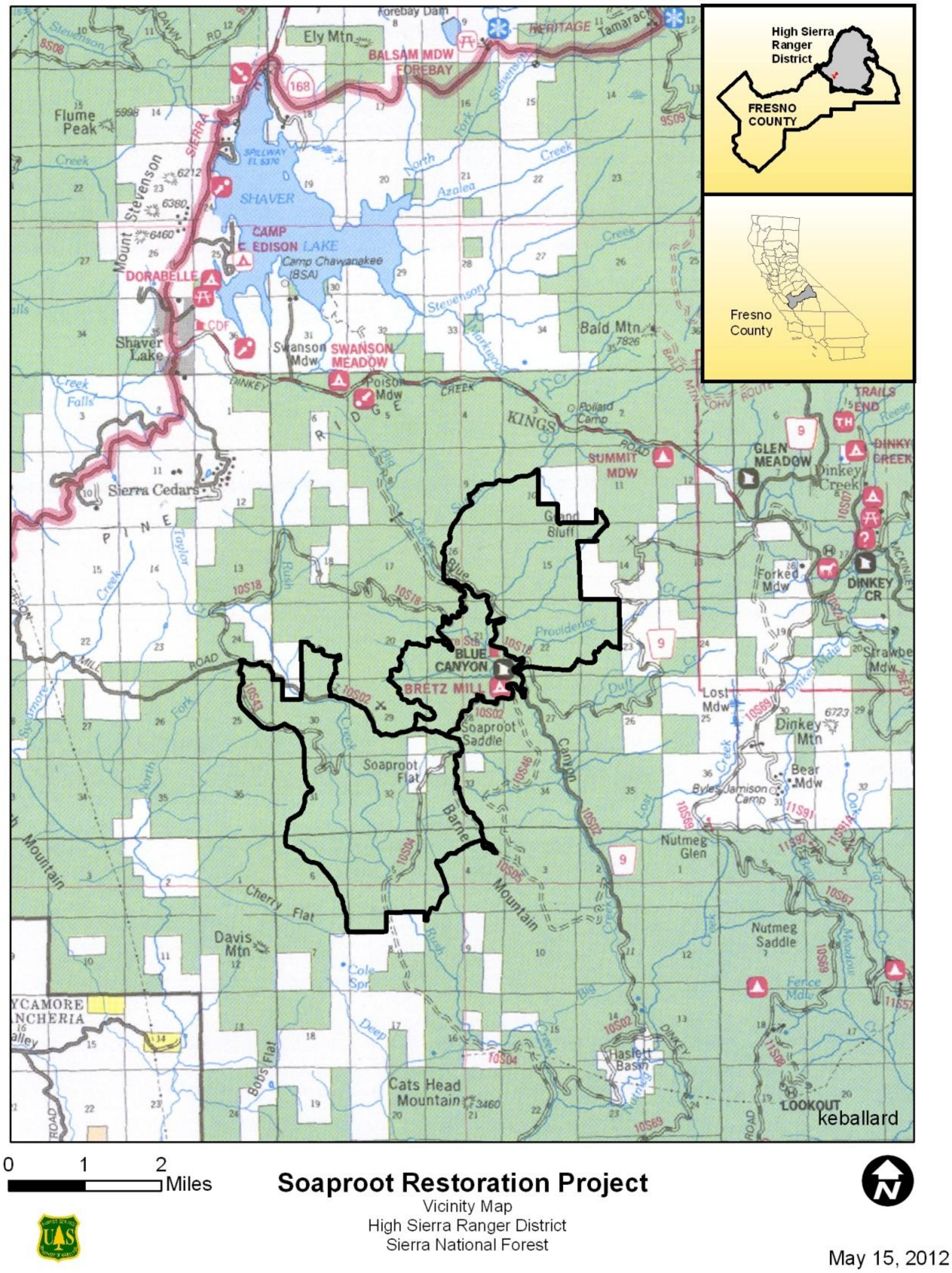

Figure 1. Project Vicinity Map

1.2. Collaboration

1.2.1. Dinkey Collaborative

Under the guidance of HFRA, a collaborative group of diverse stakeholders assembled to direct the planning approach for the Project. The group, known as the Dinkey Collaborative, represents local landowners, Native American Tribes, forestry and timber industries, environmentalists, the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD), California Department of Fish and Game (CDFG), Highway 168 Fire Safe Council, and the SNF (see Section 0 for a complete list of members). Participants represent the interests of themselves and their interest groups.

The Project was selected by the Dinkey Collaborative to reduce hazardous fuels and restore ecological components within the Dinkey Landscape Restoration Project (DLRP). The DLRP was developed under the Collaborative Forest Landscape Restoration Program (CFLRP) established by Title VI of the Omnibus Land Management Act of 2009 (Public Law 111-11). The DLRP, which includes 154,000 acres on the HSRD and adjacent private lands, was one of the projects selected to implement the collaborative, science-based ecosystem restoration of priority forest landscapes. The Project location and the proposed activities are appropriate for implementation early in the collaborative process since they have been identified as “low conflict”, indicating that Pacific fisher (*Martes pennanti*) have a low probability of occurring in the area, yet restoration activities have a high potential for creating desired habitat.

The Dinkey Collaborative developed a series of iterative agreements that address desired conditions, purpose and need, and the proposed action. The Dinkey Collaborative adopted as a conceptual framework the General Technical Report 220 developed by North et al. (2009) titled *An Ecosystem Management Strategy for Sierran Mixed-Conifer Forests* (PSW-GTR-220) (see Section 1.2.2 below for more detail); identified the key elements of the purpose and need; and identified variables that would define a desired condition across different topographic and aspect zones (i.e., canyons, slopes, and ridges with northern or southern exposures). The Dinkey Collaborative also crafted a set of decision priorities that reflect the intent to create heterogeneity (i.e., diversity in plant size, type, and density) across the landscape while addressing public health and safety and restoration needs.

A cross-disciplinary approach was used for the collaborative process to incorporate the various insights and perspectives of group members. Dinkey Collaborative members have discussed the Project in meetings since March of 2011, including one site visit, as either a full group or smaller subcommittee to work out the details of the proposed action for the Project. The Dinkey Collaborative provided input and viewpoints during the development of alternatives to consider for the Project analysis. Forum members supported the selection of alternatives, although some members have remaining ‘reservations’ (see Appendix A).

1.2.2. Landscape Strategy

The DLRP strategy identifies restoration treatments for the Project that are collaboratively developed, using PSW-GTR-220 as a foundation. Using this strategy, the Project seeks to achieve multiple goals:

- reduce hazardous fuels,
- retain and promote large tree and denning/nesting structures needed by Pacific fisher and California spotted owl (*Strix occidentalis occidentalis*),
- promote stand and landscape heterogeneity, and

- provide sufficient natural regeneration of shade-intolerant tree species for the creation of future fire-adapted forests.

The DLRP strategy incorporates long-term ecological restoration and habitat improvements through management of the existing forest structure. This strategy was first suggested by Verner et al. (1992) to better preserve the viability of the California spotted owl and other species dependent on old forest conditions. The goal of this strategy is to restore heterogeneity at the landscape scale to approximate but not strictly impose a historical condition and to create a mosaic of density and structure based on ecological processes influenced by aspect, slope position, site productivity, tree species, and unusual micro-site conditions. The most important of these historical processes is fire (North et al. 2009).

The ecosystem management strategy envisioned by North et al. (2009) is described by the abstract from the PSW-GTR-220:

> Current Sierra Nevada forest management is often focused on strategically reducing fuels without an explicit strategy for ecological restoration across the landscape matrix. Summarizing recent scientific literature, we suggest managers produce different stand structures and densities across the landscape using topographic variables (i.e., slope shape, aspect, and slope position) as a guide for varying treatments. Local cool or moist areas, where historically fire would have burned less frequently or at lower severity, would have higher density and canopy cover, providing habitat for sensitive species. In contrast upper, southern-aspect slopes would have low densities of large fire-resistant trees. For thinning, marking rules would be based on crown strata or age cohorts and species, rather than uniform diameter limits. Collectively, our management recommendations emphasize the ecological role of fire, changing climate conditions, sensitive wildlife habitat, and the importance of forest structure heterogeneity.

The use of topographic variables is described further on page 20 of the PSW-GTR-220:

> In general, stem density and canopy cover would be highest in drainages and riparian areas, and then decrease over the midslope and become lowest near and on ridgetops. Stem density and canopy cover in all three areas would be higher on northeast aspects compared to southwest. Stand density would also vary with slope becoming more open as slopes steepen.

Figure 2 is a graphic representation of how vegetation density and species mix might vary across the landscape based upon slope position and aspect. The graphic displays higher tree densities, higher canopy cover, and more shade-tolerant species such as white fir (*Abies concolor*) on the northerly slopes and in canyons. Conversely, there are lower densities, lower canopy cover, and more pines and hardwoods on southerly slopes and ridges. These conditions are reflective of those found in natural systems with more frequent and generally low-intensity fire.

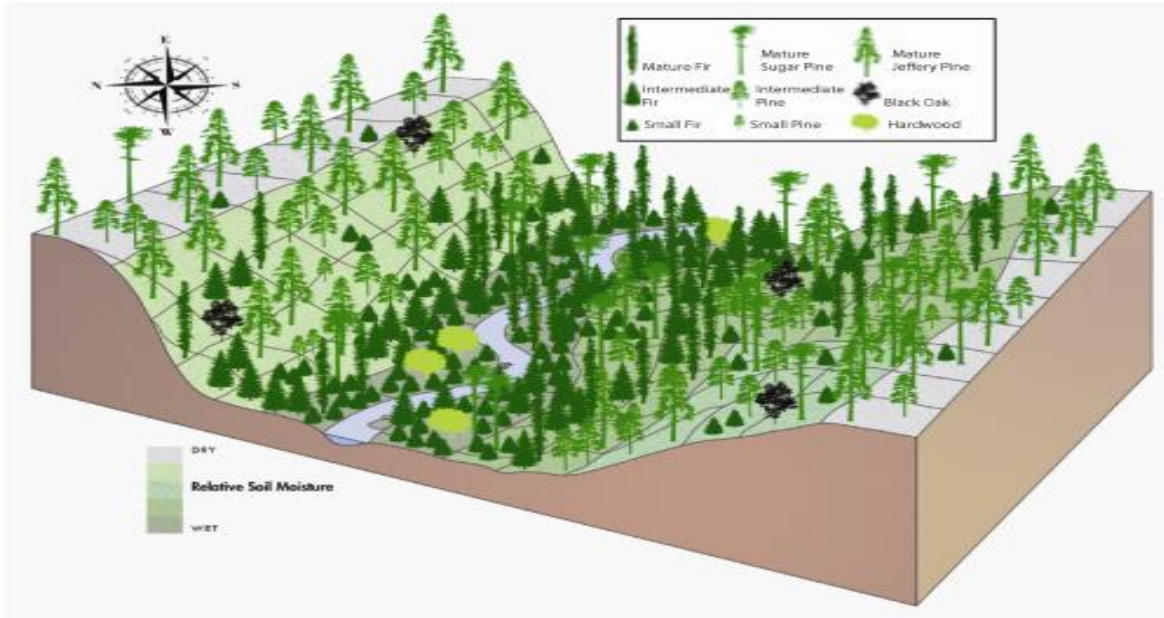

Figure 2. Representation of vegetation density and species mix in the Dinkey Landscape.

Fire was once common in the Project area (Drumm 1996; Phillips 1998) and the neighboring Teakettle Experimental Forest (North et al. 2004). Ecosystem strategies suggested by PSW-GTR-220 emphasize the use of prescribed fire as a fuel treatment and for restoring the ecological process of fire. Restoration treatments allow growing space for vegetation consistent with historical stand structures such as those at the Teakettle Experimental Forest and the Lake Tahoe Basin that had tree distributions that were generally flat across the range of tree sizes (North et al. 2004, Taylor 2004). Benefits associated with this type of treatment, which creates more open forest conditions reflective of historic forests, include greater resistance to insects, disease, and drought, resulting in a more resilient forest. Because individual tree density is reduced through thinning and fuel reduction, wildfires are less intense, reducing risks to local communities, and post-fire landscapes result in a wider range of surviving habitat types.

1.3. Existing and Desired Conditions

The SNF Land and Resource Management Plan, as amended by the 2004 Sierra Nevada Forest Plan Amendment Record of Decision (SNFPA ROD) and other documents (collectively referred to as SNF LRMP), directs that management of land and resources be designed to maintain desired conditions or to move existing conditions toward desired conditions. The following sections describe existing and desired conditions in the Project area to provide the basis for identifying needs and proposed actions to meet those needs. Landscape and stand level desired conditions were collaboratively developed by the Dinkey Collaborative. The DLRP strategy describes the attributes emphasized for desired conditions set forth for the landscape. The desired conditions in the following sections are a refinement of and are consistent with the desired conditions provided in the SNF LRMP.

1.3.1. Existing Conditions

The current conditions that exist in the Project area reflect a history of forest logging practices, grazing, and fire suppression. This has resulted in a forest structure that consists of dense, even-aged forests that are increasingly susceptible to severe wildfire and stress and mortality caused by drought, insects, and disease.

Formally ponderosa pine (*Pinus ponderosa*) and mixed conifer, the species composition in the Project area is now dominated by fire-intolerant white fir and incense-cedar (*Calocedrus decurrens*). The primary vegetation types for the Project are ponderosa pine (51 percent) and mixed chaparral (17 percent). Sierra mixed conifer covers three percent and montane hardwood conifer covers nine percent of the Project area. The overstory canopy is a mix of white fir, incense-cedar, ponderosa pine, and sugar pine with canopy cover ranging from 10 to 70 percent.

Ladder fuels and dead and down woody material have increased substantially due to fire suppression activities and natural disturbance processes such as severe storms and insect outbreaks over the past century, creating a hazardous fuels situation and making high-severity fires more likely in the Project area. Existing high fuel loadings consist of heavy surface fuels (16 to 100+ tons per acre) coupled with dense brush growth that provide for a continuous fuel bed in pine, mixed conifer and hardwood/conifer stands throughout the Project. Large brush (Mariposa manzanita [*Arctostaphylos viscida*] - 38 percent, and bear clover [*Chamaebatia foliolosa*] - 42 percent) and dense pockets of sapling-size incense-cedar and white fir dominate the understory and openings. The overstory live crown base height ranges from zero to five feet.

The air quality in the San Joaquin Valley is among the poorest in the state. Uncharacteristic wildfires tend to burn uncontrolled during the summer when air quality is at its worst. Wildfires under existing conditions would produce more smoke impeding the SNF's efforts to meet air quality standards.

Currently, there are six California spotted owl Protected Activity Centers (PACs) and/or Home Range Core Areas (HRCAs) within the Project area.

On the HSRD, Pacific fisher den site buffers have been delineated for 21 sites. At this time, of the 21 sites, four are within or adjacent to the boundary and eight are within the 3.1 mile buffer that was analyzed.

Many stream channels in the Project area are incised and are not connected to floodplains, so flood flows are rapidly conveyed downstream rather than being distributed across larger areas and replenishing water tables. Water tables may have been seasonally lowered in some areas due to channel incision. In-stream flows and sediment loads may be above natural levels due to the effects of roads and past management activities. Many stream channels have stability ratings that do not meet desired conditions, and excessive fine sediment deposits reduce the quantity and quality of pool habitat for aquatic-dependent species.

The existing condition of canopy cover in the aquatic analysis area on streams (where Stream Condition Inventory and general stream data was collected) ranges from approximately 81 to 99 percent. The reduction or removal of riparian vegetation increases solar radiation to a stream channel which affects stream temperature and primary productivity that can influence habitat for both aquatic and riparian species. Inventoried streams in the analysis area are within the expected summer temperature range (less than 21 degrees Celsius) for the zoogeographic province described by Moyle (2002), which should be appropriate for native aquatic/riparian species.

Currently in the Project area, there are approximately nine known occurrences of bull thistle (*Cirsium vulgare*) that total about 4.2 acres, 9.3 acres of Spanish broom (*Spartium junceum*), and 1.2 acres of foxglove (*Digitalis purpurea*).

There are several occurrences of threatened (T) and Endangered (E) botanical species within the Project area including Yosemite bitterroot (*Lewisia disepala*), orange annual lupine (*Lupinus citrinus* var. *citrinus*), and carpenteria (*Carpenteria californica*).

1.3.2. Desired Conditions

The SNF LRMP contains the desired condition statements for natural resources. These statements together with the DLRP strategy describe conditions that are currently not met to some degree in the Project area, and therefore identify management opportunities that were incorporated into the Project. (Additional desired condition statements apply but are not listed here.)

Forest structure would be consistent with historic fire-adapted stands. Species composition would favor those adapted to frequent fire and would focus on removal of fire-intolerant white fire and incense-cedar. Emphasis would be put toward promoting Pacific fisher and California spotted owl habitat across the landscape by retaining key nesting and denning structures and promoting stand heterogeneity.

Fire would be restored as an essential ecosystem process across the landscape at frequencies and intensities that more closely resemble those which occurred when fire regulated stand structures, species composition and age-class diversity. Wildfires would be manageable in a cost-efficient manner, without threatening sustainability of resource values or human life and property within the WUI. In the WUI defense zone, surface and ladder fuels conditions are such that sustained crown fire is unlikely. Surface fuel loading averages less than 10 tons per acre (except in PACs where more than 10 tons per acre of large down woody material over 12 inches DBH are retained). The overstory live crown base height averages a minimum of 15 feet.

Air quality standards and visibility would be compatible with federal, state, and local laws, including a program that achieves the Clean Air Act responsibilities.

The connections of floodplains, channels, and water tables distribute flood flows and sustain diverse habitats. In-stream flows are sufficient to sustain desired conditions of riparian, aquatic, wetland, and meadow habitats and keep sediment regimes as close as possible to those with which aquatic and riparian biota evolved. The physical structure and condition of stream banks and shorelines minimizes erosion and sustains desired habitat diversity. Sites of accelerated erosion, such as gullies and headcuts, are stabilized or recovering. Vegetation roots occur throughout the available soil profile.

Habitat supports viable populations of native and desired non-native plant, invertebrate, and vertebrate riparian and aquatic-dependent species. New introductions of invasive species are prevented. Where invasive species are adversely affecting the viability of native species, the appropriate state and federal wildlife agencies have reduced impacts to native populations.

The species composition and structural diversity of plant and animal communities in riparian areas, wetlands and meadow provide desired habitat conditions and ecological function. The distribution of health and biotic communities in special aquatic habitat (such as springs, seeps, vernal pools, fens, bogs, and marshes) perpetuates their unique functions and biological diversity.

Spatial and temporal connectivity for riparian and aquatic-dependent species within and between watersheds provides physically, chemically, and biologically unobstructed movement for their survival, migration and reproduction. Soils with favorable infiltration characteristics and diverse vegetative cover absorb and filter precipitation and sustain favorable conditions of stream flows. Large wood debris would be in riparian areas to provide wildlife cover and to regulate stream temperatures.

For botanical resources, areas of known occurrences of botanical species would be preserved or increased. Noxious weeds would decrease in known populations.

1.4. Purpose and Need for Action

The SNF LRMP provides direction to maintain and restore ecological sustainability and emphasizes the need to modify wildland fire behavior across broad landscapes through the strategic placement of area treatments, reduce stand density and improve tree vigor, and to improve overall forest health. The following needs are tied to the overarching purpose to restore a healthy, diverse, fire-resilient forest structure in the Project area:

- There is a need to protect adjacent landowners and private property from the effects of wildfire. Existing fuel loadings and dense conifer stands within the Project area raise the potential for fire to spread rapidly within the WUI, threatening nearby communities, private property, and natural resources. The SNF LRMP's highest priority has been given to fuel reduction activities in the WUI to protect human communities from wildland fire as well as minimize the spread of fires that may originate in urban areas. The existing fuel conditions also increase the risk to firefighters and the public.
- There is a need to restore a vigorous, diverse, forest ecosystem that is resilient to the effects of wildfire, insect and disease, air pollution, and climate change. Frequent low-intensity fire historically controlled surface fuels and tree density, which has been interrupted by fire suppression. The need to reintroduce fire as an ecosystem process is better understood today.
- There is a need to reduce smoke production from wildfire and prescribed fire. The risk of adverse effects to air quality and public health from smoke production caused by wildfire and prescribed fire increases as the amount of hazardous fuels increase.
- There is a need to protect denning, resting, and nesting structures from future wildfire and to enhance these structures, as well as foraging habitat for Pacific fisher and California spotted owl. Wildfire poses an immediate threat to the survival of the Pacific fisher and California spotted owl due to the high fuel loadings. For the Pacific fisher, this threat can only be reduced by decreasing the quantity and distribution of fuels (CBI 2008).
- There is a need to improve watershed resilience and function and improve aquatic habitat for sensitive wildlife species.
- There is a need to reduce the spread of noxious weeds and to protect sensitive botanical species within the Project area. Noxious weeds can displace native plants, causing additional fuels hazards, reduce the cover of native plants, and take up resources needed by seedlings.

1.5. Proposed Action

The SNF proposes to apply restoration treatments to approximately 6,958 acres. Outside of fisher den buffers and spotted owl PACs, vegetation treatments would follow the guidelines outlined in the PSW-GTR-220 with an emphasis on retaining denning structures and creating and enhancing gaps and pockets of high density. Within den buffers and PACs, ladder fuels treatments would follow the recommendations made by the Dinkey Collaborative Joint Fact Finding Committee. Fuels treatments would include mechanical, hand, and prescribed fire methods. Plantation treatments would include pre-commercial thinning, site preparation, planting and release using herbicides. Noxious weeds would be eradicated using manual and chemical methods. Watershed and riparian treatments are also proposed in the Project area. This action responds to the goals and objectives outlined in the SNF LRMP, and helps move the Project area towards desired conditions described in that plan.

Section 2.1.2 provides a detailed description and figures of the proposed action.

1.6. Decision Framework

Given the purpose and need, the deciding official reviews the proposed action and the other alternatives in order to make the following decisions:

- Whether to implement the proposed action, take action through an alternative combination of activities, or take no action at this time, and
- Provide sufficient evidence and analysis for determining whether to prepare an EIS or a FONSI (Forest Service [FS] Handbook [FSH] 1909.15, Chapter 41.1).

1.7. Public Involvement

The Project was first listed in the Schedule of Proposed Actions (SOPA) on January 1, 2011 (first quarter) and has since been listed in each quarterly SOPA. A web link to the SOPA can be found on the FS projects web page at: http://www.fs.fed.us/sopa/forest-level.php?110515.

In addition, the agency used the collaborative approach described above under Section 0. The Dinkey Collaborative met several times beginning in January 2011 for full collaborative meetings, field visits, and technical sub groups.

The proposed action was provided to SOPA respondents and other interested individuals, Native American Tribes, adjacent landowners, permittees, organizations, and government agencies for comment during scoping from June 10, 2011 to July 10, 2011. A public notice was published in the *Fresno Bee* on June 11, 2011. At the end of the scoping period, a total of four responses were received. The Interdisciplinary Team (IDT) reviewed the comments received and developed a list of issues to address in the analysis.

1.8. Issues

The SNF separated 37 comments from the four response letters brought forward by the public into three categories:

1. Issues to be addressed through the development of an alternative/s.
2. Concerns or recommendations for the Project that could be resolved through the use of design criteria or addressed in the effects analysis.
3. Comments that have no issues, comments that are deemed to be outside the scope of the Project, or a request for information.

Issues (category 1) are points of disagreement, debate, or dispute about the potential for the proposed action to have potential adverse effects and are used to formulate alternatives to the proposed action.

Concerns or Recommendations (category 2) include comments that have already been addressed in the proposed action, will be addressed in the effects analysis, and/or additional Project design criteria will be developed which reduce or eliminate the effects. This category also includes comments that are requesting a change/clarification in process (EA vs. EIS) or in the Project.

Non-Issues (category 3) are those deemed to be beyond the scope of the proposed action; irrelevant to the decision to be made; already decided by law, regulation, or policy; are requests for information to be included in the environmental documents or elsewhere; are conjectural in nature, not supported by scientific evidence; are analyzed under previous environmental documents; or have no apparent issue or are supportive of the Project or specific parts of the Project in general.

A list of non-issues and reasons regarding their categorization as non-significant may be found in the Soaproot Restoration Project Scoping Summary Report located in the Project record at the HSRD office in Prather, CA. A response letter from Chad Hanson included many comments that were geared toward an environmental document (EA/EIS) and not towards a scoping notice. Many of these comments were addressed in this EA and associated specialist reports but were not considered issues.

The SNF identified one issue raised during scoping. The issue raised by Chad Hanson recommended that the FS should not remove mature/old trees up to 30 inches diameter at breast height (DBH); the FS should provide scientific support for the 30 inch DBH limit on mechanical thinning; Further, the FS should consider three separate alternatives for the acres proposed for mechanical/commercial thinning that would use prescribed fire only, and no thinning, that would use a 12 inch DBH limit, and that would use a 16 inch DBH limit for removal, with those over 16 inches DBH being girdled or killed another way than removing. This issue is addressed in the alternatives described in Section 2.0.

1.9. Scope of Analysis

This EA focuses on potential effects to several resource areas responding to the issue raised during scoping and the purpose and need for the Project (see Section 3.0). The EA analyzes resources that may be perceived as being significantly affected by the Project and demonstrates the SNF's compliance with environmental regulations including the SNF LRMP. These resource areas include: fire and fuels, air quality, vegetation, terrestrial wildlife, watershed and riparian, aquatic resources, and botanical resources. A few subject areas that were not brought up as issues during scoping and are not part of the purpose and need for the Project, but are however topics of interest brought up during scoping or through the collaboration process, are briefly summarized in Section 3.0 and include climate change, socioeconomics, and the black-backed woodpecker.

A few other resource areas are sometimes also included in forest health related environmental analyses. No scoping issues were raised related to these resource areas. There will not be significant effects to these resources for the reasons described below therefore the SNF has decided not to analyze these resource areas further in this document.

Visual Resources[3]: The Highway 168 and Dinkey Creek Road are near the Project and are key viewing points identified in the SNF LRMP from where the public views the landscape and has high concerns for scenic values. Alongside Highway 168 and Dinkey Creek Road, "walls" of trees or earth forms (hillsides, rock cliffs, rolling hills) enframe the views directing the viewer's attention inwards and screening views beyond the immediate foreground (0 to 300 feet). Common to all action alternatives, there would be no adverse effects to scenery as the Project would not be visible to the casual SNF visitor from Highway 168 and Dinkey Creek Road and would comply with the SNF LRMP Visual Quality Objective (VQO) of Retention.

The Bretz Campground is within the Project area and is a key viewing point from which the public views the landscape and are less sensitive to visual change when compared to Highway 168 and Dinkey Creek Road. There are no treatments proposed within the Bretz Campground for either action alternative; however, the surrounding underburn activities may be visible from Bretz Campground as seen within the foreground (up to half a mile), but would be subordinate to the surrounding area where underburn activities have occurred in the past. In addition, scenery design criteria applicable to underburn activities have been included in both action alternatives to mitigate visual impacts of the prescribed fire. Therefore, there would be no adverse effects to scenery as the Project would not affect the scenic quality as seen from Bretz Campground and would comply with the SNF LRMP VQO of Modification. Because driving to the destination is part of the recreation and scenery experience and to comply with the SNF LRMP VQO of Modification, several scenery design criteria have also been included in the action alternatives to apply along private property, Peterson Mill Road, FS road 10S02, FS road 10S17, and FS road 10S18. This is common to all action alternatives.

[3] More information on visual resources can be found in Soaproot Project – Visual Resources (Scenery) (Sanchez. C. 2012). This document is herein incorporated by reference and available in the Project planning record located at the HSRD office.

Transportation[4]: Although temporary road construction/reopening, road reconstruction, and road maintenance would occur in the Project area (see Section 2.1.2.5), the mileages are very small in comparison to the SNF National Forest Transportation System (NFTS) which includes 2,500 miles of roads. Approximately two percent of the NFTS would be affected by the alternatives. Additionally, engineer-approved design criteria have been included in all the alternatives to comply with FS road maintenance and construction guidance.

Cultural Resources[5]: Cultural resources have been considered in all aspects of the Project. Although the Project has the potential to damage or destroy cultural resources from the potential effects of vegetation management, fuels reduction treatments, and other proposed actions, specific protection and management measures would be applied to archaeological sites as Project design criteria (see Section 2.1.4.1, Cultural Resources). There would be no direct effects to cultural resources with archaeological values since known sites do not occur in a proposed treatment area or would be protected with the Project design criteria. There is no difference in cultural resource management between the action alternatives, as the alternatives do not differ in areas treated, only in size of timber harvested and use of herbicides.

2.0. Alternatives, Including the Proposed Action

Through the process of issue management (see section 1.8), the IDT identified scoping comments with issues that could be resolved through an alternative to the proposed action. The IDT did a preliminary analysis of the potential alternatives developed from these scoping comments to determine which were reasonable. A reasonable alternative is one that responds to an argument presented in a significant issue and substantially accomplishes the purpose and need of a project. If an alternative does not fit the description of a reasonable alternative it is dropped from detailed consideration. Alternatives considered but eliminated from detailed study are summarized at the end of this section (see section 2.2).

2.1. Alternatives Considered in Detail

This section describes and compares the alternatives considered in detail for the Project, including the proposed action and a non-commercial funding alternative. During scoping, a comment was received that requested for three alternatives to be fully developed that did not involve the removal of large trees. These included a “prescribed fire only” alternative that was eliminated from detailed study (see Section 2.2), a “thin to 12 inch DBH limit” alternative and a “thin to 16 inch DBH limit with those over 16 inches being girdled” alternative of which the main purpose would be to create snags. The latter two were used in the development of the action alternatives described below.

2.1.1. Alternative 1 (no action)

Under the no action alternative, no new actions would be implemented to accomplish Project goals. Current management plans would continue to guide management of the Project area. In general,

[4] More information on transportation can be found in the Transportation Analysis prepared for the Soaproot Restoration Project. This report is herein incorporated by reference and is available in the Project planning record located at the HSRD office.

[5] More information on cultural resources can be found in the Cultural Resource Management of the Soaproot Restoration Project, Archaeological Reconnaissance Report R2012051552001. This report is herein incorporated by reference and is available in the Project planning record located at the HSRD office.

existing Project conditions would continue as they are. Existing vegetation and fuels would not be treated in natural stands or plantations within the Project area. The Rush Creek crossing on FS road 10S04 would not be modified and Watershed Improvement Need (WIN) sites would not be treated (unless addressed through routine road maintenance). The analysis of the no action alternative provides reviewers a baseline to compare the magnitude of environmental effects of the action alternatives and the potential long-term impacts from not implementing the Project.

2.1.2. Alternative 2 (proposed action)

Alternative 2 is a refinement of the original proposed action that was distributed for public scoping on June 10, 2011. Changes are based on scoping comments and input from the Dinkey Collaborative to incorporate treatment recommendations in Pacific fisher den buffers and California spotted owl PACs from the Dinkey Collaborative Joint Fact-Finding Committee, to identify and emphasize gaps and high-density pockets, and to identify and retain denning structures.

In the proposed action, restoration treatments would occur within approximately 6,958 acres to reduce hazardous fuels and restore ecological components. This involves a combination of manual, mechanical, and prescribed fire treatment methods in stands, plantation maintenance, watershed and riparian area treatments, noxious weed eradication, reforestation treatments, road maintenance, and temporary road construction to accomplish the Project objectives. There are no treatments proposed within Bretz Campground. Within the Project boundary, there would be stands with no treatment and others that include multiple treatments to meet the goals and desired conditions of the Project. Proposed treatments are described below and are summarized in Table 1. A table showing treatment acres for each planID (a unique identifier for each stand) is included in Appendix D.

Table 1. Summary totals of proposed treatments for alternative2 in acres.

Treatment	Acres
Restoration Thin	**887**
Ladder Fuels - mech	**654**
Ladder Fuels - hand	**29**
Plantation Maintenance	**36**
Fuel Treatments	**1873**
Tractor Pile	742
Grapple Pile	814
Hand Pile	29
Mastication	68
Lop & Scatter	83
Crush & Brush	137
Prescribed Fire Treatments	**3886**

Treatment	Acres
Burn Piles (tractor, grapple, hand)	1585
Jackpot Burn	15
Underburn	1248
Broadcast Burn	146
Reforestation Treatments	**176**
Site Prep (chem 1)	176
Release (chem 2)	176
Planting	176
Noxious Weed Eradication	3

Restoration treatments are designed to decrease fuel loads and stand densities in order to restore the landscape to a healthy, diverse, fire-resilient one that would aid in disrupting severe wildfires that may occur around the WUI. This would be accomplished by reducing surface and ladder fuels, promoting and maintaining heterogeneity at multiple scales, maintaining and improving habitat for sensitive wildlife species, improving watershed function and resilience, and restoring native species composition. All applicable Standards and Guidelines (S&Gs) stated in the SNF LRMP are incorporated into the proposed treatments.

2.1.2.1. Vegetation Treatments

The proposed action would involve the following vegetative thinning treatments to promote heterogeneity and allocate growing space consistent with historical stand structures. The prescriptions are designed to maintain the suitability of sensitive species habitat, while remaining consistent with fuels and fire objectives. Vegetation treatments proposed would occur as three different prescriptions and are based on whether they occur inside of fisher den buffers and spotted owl PACs, outside of these areas, or within plantations (see Figure 3). To meet fuels objectives, snags up to 30 inches DBH would be removed (see Section 2.1.4.2 for applicable design criteria). The SNF LRMP objectives to retain four of the largest snags per acre would be met. These prescriptions are described below.

Restoration Thin Prescription

Restoration thinning would occur outside of Pacific fisher den site buffers and outside of California spotted owl PACs that are not within the WUI defense zones. The restoration thin prescription would use concepts from the PSW-GTR-220 report, using topographic variables, to guide treatments proposed for the Project. These treatments would have an emphasis on retaining denning structures and creating and enhancing gaps and pockets of high density. Creation of gaps would occur in incense-cedar thickets that average 10 inches DBH or less and would range from one-half to two acres in size. The gaps would be created in pockets of tree mortality caused mainly by the bark beetle. Within these pockets, four to six of the largest snags per acre would be retained and all trees greater than 30 inches DBH would be retained. Small, unmapped riparian areas located throughout the proposed treatment stands would be treated to retain or increase the dominance of vegetation consistent with restoration objectives.

Commercial tree harvest methods to be used involve mechanical ground-based equipment (tracked or rubber-tired mechanical harvesters) to remove conifer trees up to 29.9 inches DBH. In compliance with the SNF LRMP, trees with a DBH of 30 inches and greater would be retained throughout the Project area except where they pose a safety or structural hazard. Tree removal would focus on white fir and incense-cedar and suppressed trees of all species. Priority tree species to retain would be disease-free sugar pine, ponderosa pine, California black oak, and quaking aspen; the tallest trees; trees with the largest crowns and straightest boles that are free of damage from insects, disease and physical or mechanical causes. Trees with potential fisher resting structures such as mistletoe witches brooms, multiple tops, or stem rot greater than 20 inches DBH are also a priority for retention.

The restoration thin prescription is broken down into five zone treatments based on aspect, slope position, site productivity, tree species and recognition of micro-site conditions. This prescription would create varying stand density and structure throughout the Project area. Marking guidelines used in other restoration projects such as Dinkey North and Dinkey South would be adapted for use in the proposed action.

Ladder Fuels Prescription

Within fisher den buffers and spotted owl PACs, mechanical and hand ladder fuel treatments would follow the recommendations made by the Dinkey Collaborative Joint Fact Finding Committee. These recommendations include avoiding treatment within the den buffers and PACs if possible and would limit thinning to trees equal to or less than 12 inches DBH. Where fire objectives necessitate removal of any mid-sized trees (12 to 16 inches DBH), the trees that would be marked for removal and their location would be documented, as well as smaller trees (less than 10 inches DBH) that would intentionally remain within the den buffers and PACs.

Current and past fisher den sites consisting of the highest quality habitat would require a 700 acre buffer. Designation of den buffers would be achieved using new information that comes from current research up until a contract for the Project would be awarded. After that point, new information would still be collected and utilized but the prescription in the buffers would not change for this Project.

Plantation Maintenance

There are a number of plantations within the Project area that were originally included in the scoping document. These plantations have since been analyzed under a separate NEPA document (Snowy Patterson) and would not be treated in this Project.

There are three stands with plantations that are not part of the Snowy Patterson Project and are still included in this Project to accelerate development of large trees and meet ecological restoration objectives. The plantation maintenance prescription would be applied to these plantations. This prescription consists of a pre-commercial thin (trees less than 10 inches DBH). Mechanized equipment such as masticators or mechanical harvesters would be utilized.

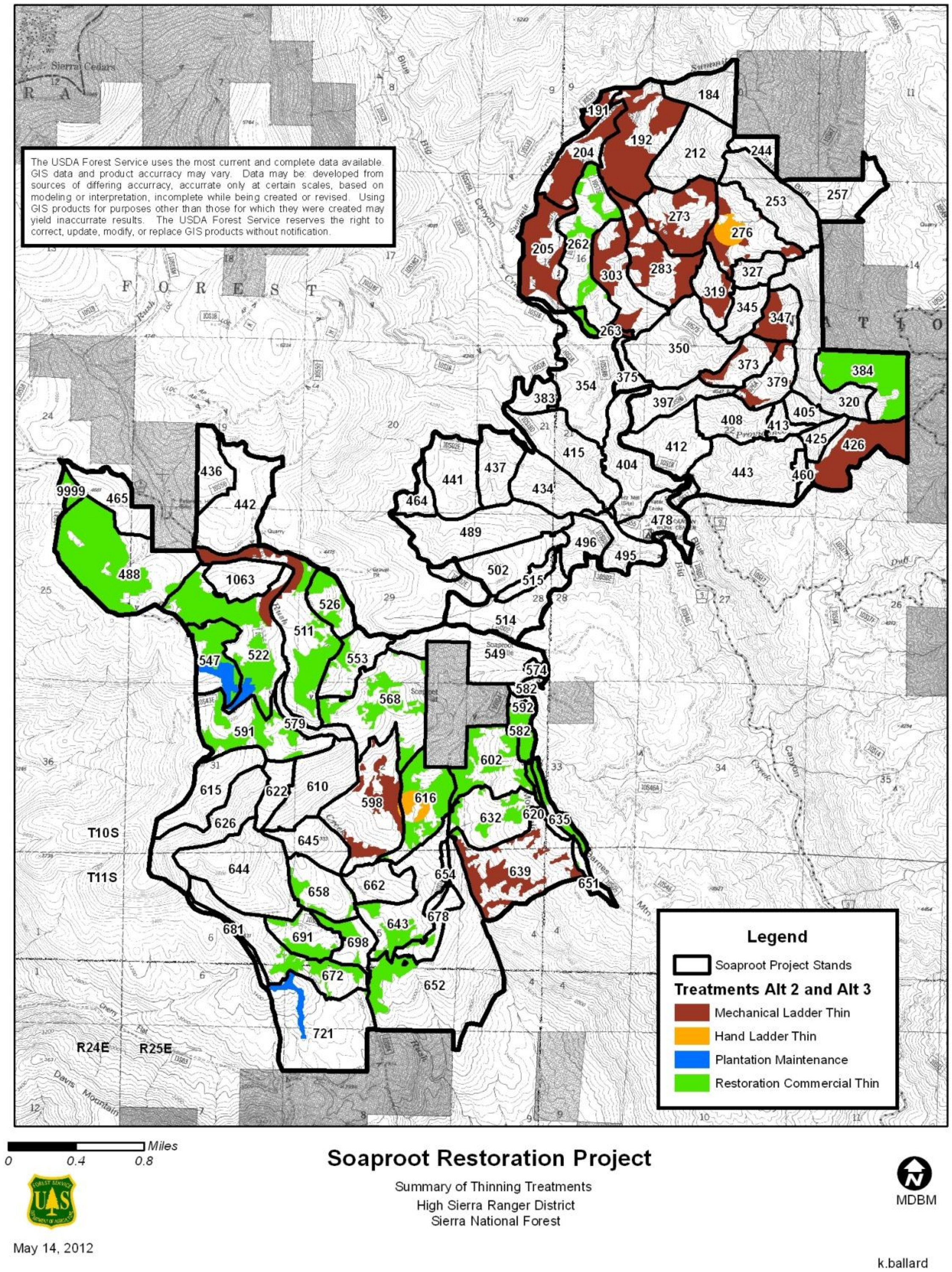

Figure 3. Display of vegetation treatments proposed for alternatives 2 and 3.

2.1.2.2. Fuels Reduction Treatments

In stands where the level of dead and down woody debris exceed the fuels objectives of 10 to 15 tons per acre (SNFPA S&Gs 4 & 5), fuels reduction treatments would be used to lower the volume of flammable brush and slash across the Project area (see Figure 4 and Figure 5).

Fuels Prescriptions

The fuels prescriptions involve the manual and mechanical rearrangement of fuels created from harvesting activities or natural processes. These activities would occur after proposed vegetation treatments are completed and would be followed by prescribed fire or another method to reduce the fuels.

Dead and down woody material would be mechanically or manually piled depending on the area and would be later burned. Hand piling of fuels would occur in treatment areas proposed for the hand ladder fuels prescription. Tractor piles of fuels in plantations, restoration thin, and reforestation treatment areas would be created using a brush rake attached to a tracked vehicle. In watersheds where cumulative watershed effects (CWEs) are a concern, grapple piling would occur in riparian conservation areas (RCAs[6]) to minimize ground disturbance, especially on slopes greater than 25 percent (SNF LRMP, S&G 120).

Mastication (mechanical shredding) of brush and dead and down woody fuels would occur following restoration thinning to reduce surface and ladder fuels and would be followed by a jackpot burn. Mechanical equipment used is typically tracked with a cutting head mounted on an articulating arm and is able to reach slopes greater than 35 percent with the articulating head.

Lop and scatter of fuels is a hand method involving chain saws or lopping shears to cut up and distribute slash from tops and boles of small trees so that the material is within 24 inches of the ground. This is so hot or sustained fire is not promoted throughout the Project area due to the vegetation treatments that would occur.

Crush brush using a dozer would occur to prepare brush fields for broadcast burn treatments. This aids in the creation of a variety of different age classes that would assist in reducing the potential for extreme fire behavior.

Prescribed Fire

Ecosystem strategies suggested by North et al. (2009) emphasize the use of prescribed fire both as a fuel treatment and as a tool for restoring natural processes. Four prescribed fire methods would be used: burn piles, jackpot burn, underburn, and broadcast burn. Where there are no existing control lines (e.g., roads, natural barriers), firelines would be constructed (approx. 10,300 feet). On slopes less than 35 percent, firelines would be tractor constructed and on slopes greater than 35 percent, handline would be constructed. Both types of lines would involve scraping down to mineral soil and constructing waterbars for erosion control.

Piles generated from hand and mechanical equipment (tractor and grapple) would be burned within the treatment areas. Underburning is proposed to accomplish restoration objectives and reintroduce the process of frequent fire by burning the understory of treatment units with tree canopy overstory. In brush fields, where the crush brush method would be used, a broadcast burn would follow.

[6] RCAs are delineated around perennially and seasonally flowing streams and special aquatic features. They extend 300 feet from perennial features and 150 feet from seasonal areas (see design criteria section).

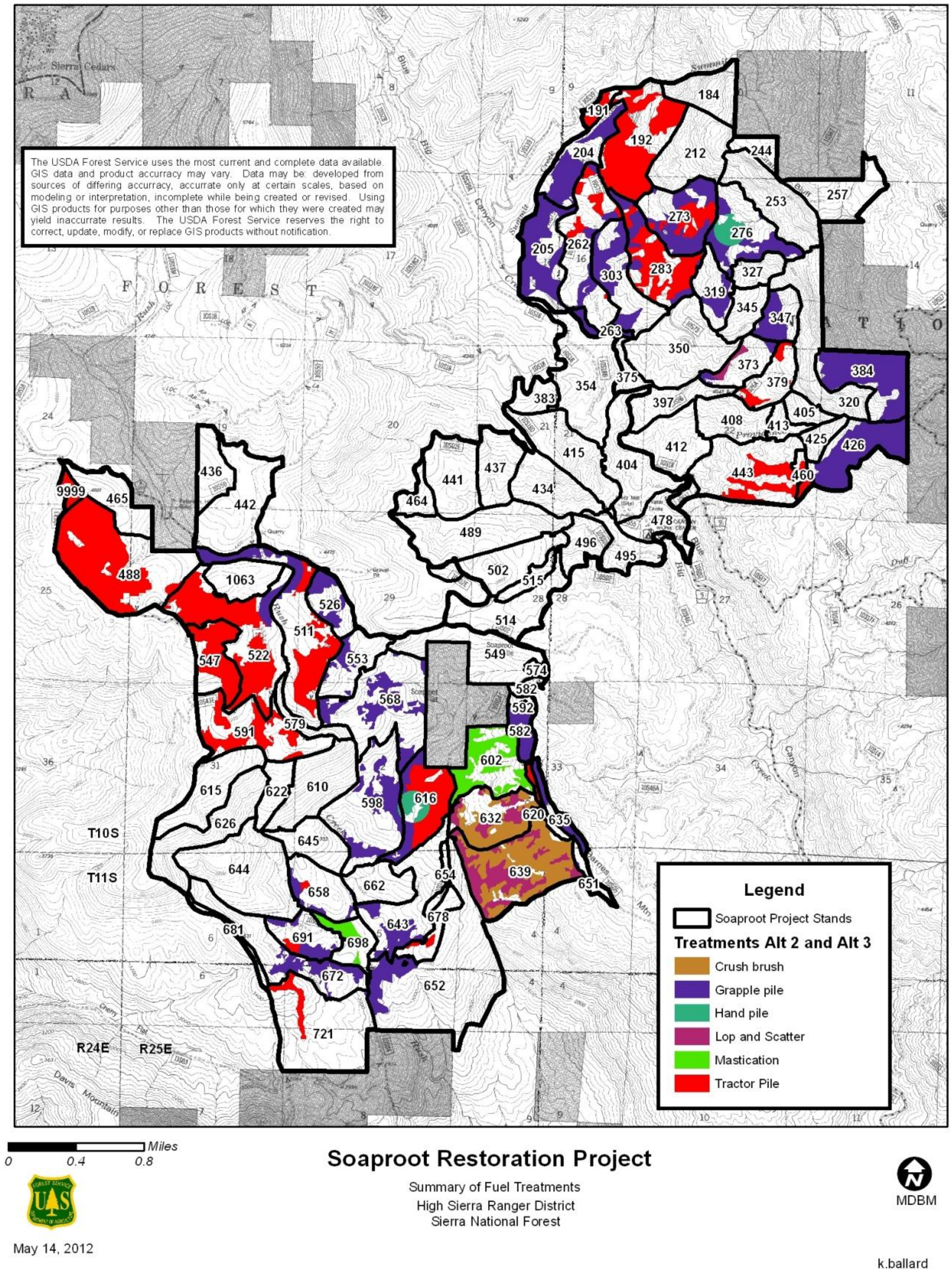

Figure 4. Display of fuel treatments proposed for alternatives 2 and3.

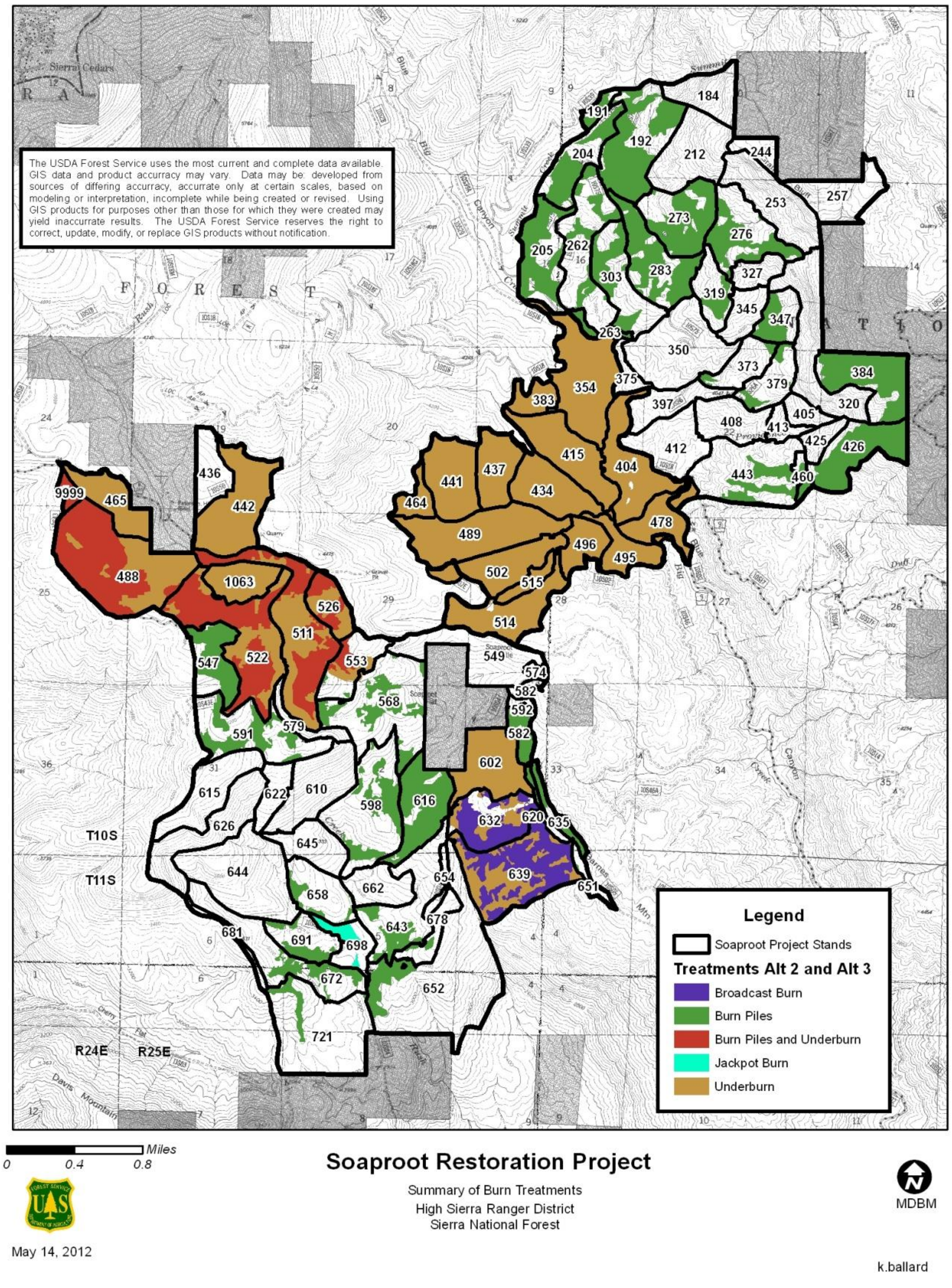

Figure 5. Display of prescribed fire treatments proposed for alternatives 2 and 3.

2.1.2.3. Reforestation Treatments

Restoration of native species composition is proposed through the regeneration of pine species; the retention of existing shrubs, pine, aspen, and oaks consistent with the desired condition, the enhancement of growing conditions for existing pine, and the eradication of noxious weed species. Both younger shrub age classes and pine regeneration are proposed for restoration in existing openings. Reforestation would occur through mechanical and manual site preparation prior to planting (where applicable), followed by planting and release of the seedlings (see Figure 6). These treatments would occur in a few stands proposed for vegetation treatments but would not occur within plantations. Acres and stands for reforestation treatments in the Project area are estimates (see Section 2.1.4.2, #6).

Site preparation treatments in regeneration openings are proposed to reduce competing vegetation prior to the planting of conifer seedlings. Effectiveness of site preparation treatments should consider whether or not a competing plant would sprout from its root system. Removing the above ground vegetation of sprouting plants is only a short-term treatment. Site preparation is conducted in combination with mechanical and manual fuels treatments.

Planting treatments include hand planting of bare-root or container-stock pine and fir at various composition levels. The goal for planting species composition is to return to the mix consistent with frequent fire regimes. Planting would occur in existing openings and seedlings would be spaced accordingly.

Release treatments would occur after planting to control vegetation that is competing with the planted or naturally occurring trees, including noxious weeds that are present or have re-invaded the site after site prep treatments. This involves removing the competing vegetation using manual, mechanical, or chemical methods, or a combination of these methods. To be effective, release treatments need to remove vegetation within a five foot radius around each tree. Chemical applications of glyphosate herbicide plus surfactant R-11© would be a direct spray to target species that would compete with the conifer seedlings planted. Extensive re-sprouting is usually eliminated with this type of treatment.

Noxious weed eradication would be used on scotch broom and bull thistle occurrences in the Project area. The same herbicide used in the release treatments would be used for treatment of noxious weeds.

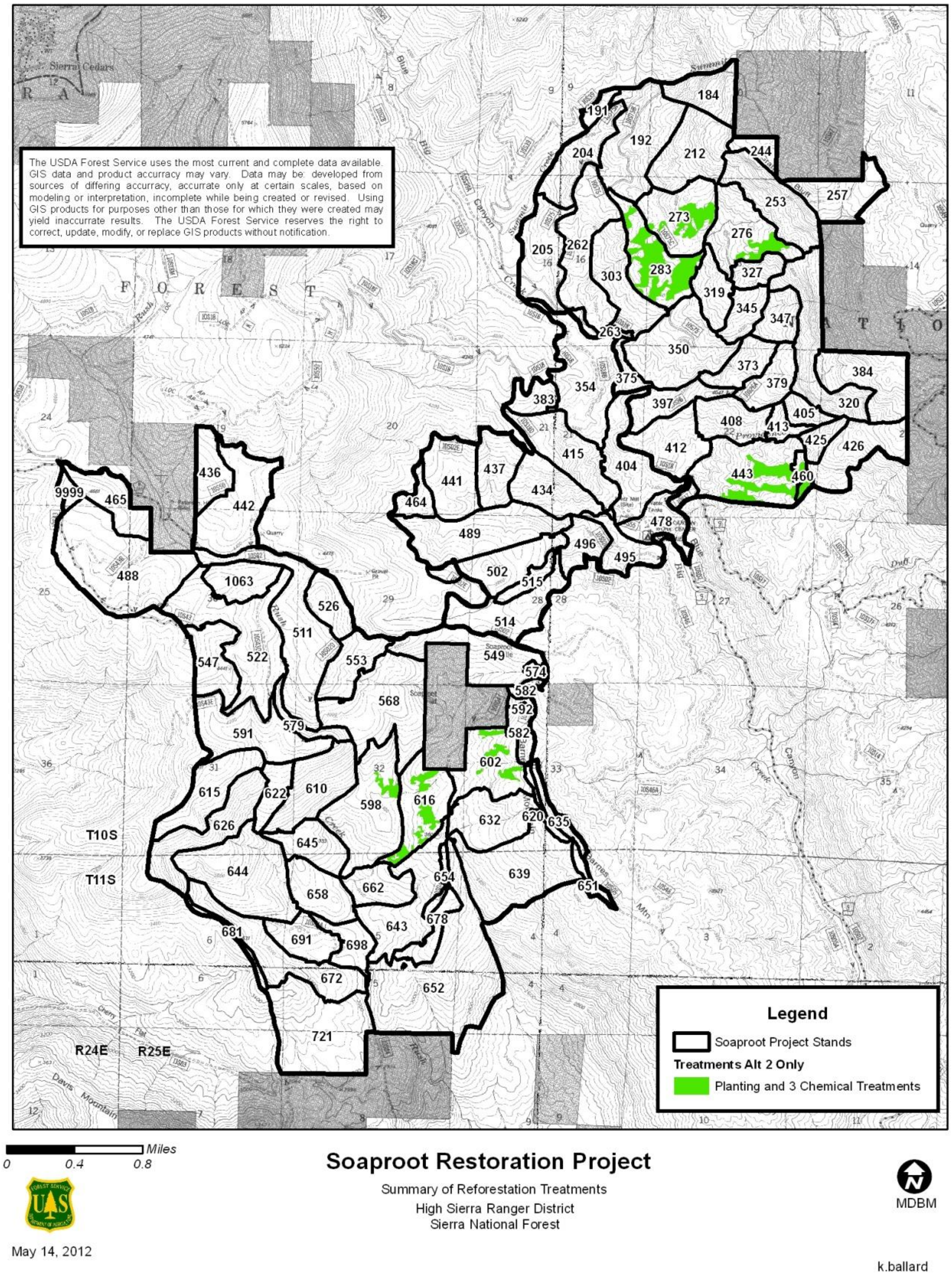

Figure 6. Display of reforestation treatments proposed for alternative 2 only.

2.1.2.4. Watershed and Riparian Restoration Treatments

Treatments are proposed for WIN sites to control erosion and maintain or improve the resilience and function of watershed and riparian areas within the Project. Documented WIN sites and the proposed treatments for each site are listed in Table 2 and described below.

Stabilize channel / stabilize stream banks – Actions are specifically tailored to each site and address the cause of instability at that location. Possible treatments include: reshaping stream banks to a more stable angle; installing jute netting or other erosion control product; establishing woody or herbaceous riparian vegetation; or placing rock to harden vulnerable areas or redirect stream energy.

Install erosion control – These actions are also tailored to the site-specific processes causing erosion at a given location, and focus on establishing ground cover. Methods could include jute netting or other erosion control product; establishing vegetation; placing rock; or placing rock or wood dissipaters to encourage water dispersal and sediment deposition.

Improve road drainage – This includes actions related to managing the flow of water along and off of the road. This could entail grading; maintaining or installing rolling dips to direct water off the road; cleaning or rocking the roadside ditch; cleaning, replacing, or adding ditch relief culverts; or spot rocking the road surface so that it is less prone to rutting. Improving road drainage could be considered road maintenance or road reconstruction, depending on how much work is entailed.

Maintain road / Reconstruct road – Reshape existing road template to function as designed. This can include removal of encroaching roadside vegetation. The term 'reconstruction' is used when elements of the designed road are no longer present (for example, rolling dips are completely filled or eroded and not enough of the structure remains to simply reshape), when additional structures must be added (for example, the spacing of rolling dips is decreased, requiring construction of new dips), or when the road template is changed (for example, an insloped road with a ditch and ditch relief culverts is changed to an outsloped road).

Realign and obliterate road segment – A specific segment of road with chronic erosion problems that cannot be repaired in place would be closed and obliterated, and a new segment would be constructed that would avoid the problem area. Obliteration would be accomplished using heavy equipment and handwork, and could include: ripping to increase infiltration; recontouring the ground surface to more closely match the natural slope; and placing rock and native materials such as down logs and forest litter for groundcover.

Improve stream crossing – Stream crossing improvements could include: installing a new or replacement culvert; hardening the road or trail approach to the crossing to minimize erosion; hardening the crossing itself (construction of a hardened ford crossing); improving drainage of road or trail runoff to prevent it from entering the stream at the crossing; or stabilizing stream banks adjacent to the crossing.

Rehabilitate skid trail – Best Management Practices (BMPs) include techniques for properly closing skid trails to prevent erosion. However, one of the WIN sites in this Project area documents erosion on an old skid trail that was either not properly closed or where the closure treatments were ineffective. At this location, treatments similar to those described for road obliteration would be used as needed to prevent ongoing erosion and ensure recovery of the area.

Table 2. Documented WIN sites and proposed treatments within the Project.

WIN Site #	Treatment Unit	Description	Proposed Treatment
54138	Soaproot	Sediment delivery from 10S43 to Rush Creek	Improve road drainage; install erosion control between road and creek
54274	Soaproot	Sediment delivery from 10S90 (Poker Run Segment E) to Rush Creek	Realign 10S90 and obliterate problem segment.
54340	Soaproot	Road and stream crossing erosion, multiple locations on 10S04A	Reconstruct road; install temporary stream crossing; decommission road after use (approximately 0.8 miles)
54381	Soaproot	Sediment delivery from 10S04 at Rush Creek ford crossing	Improve road drainage near crossing
54133	F16 Burn	Erosion in ephemeral meadow channel	Improve road drainage to protect meadow from road runoff; stabilize channel
54289/54306	F16 Burn	Road surface erosion on 10S404	Maintain or reconstruct road
54282/54431	Providence	Headcut erosion in annual grassland opening (not a riparian meadow)	Stabilize stream channel
54435	Providence	Skid trail erosion	Improve drainage and rehabilitate skid trail
54433/54436/ 54473b	Providence	Erosion on 10S75 and 10S75C	Reconstruct roads
54288/54469/ 54467	Providence	Stream crossing / culvert problems on 10S75A and 10S75B	Improve stream crossing designs during road reconstruction
54437/54438/ 54439/ 54440/54500	Providence	Erosion on 10S75D (Poker Run Segment H)	Improve drainage; install sediment basin
54428	Providence	Culvert outlet creating severe gully erosion, 10S18	Improve road drainage (add and/or move culvert)
54281/54429	Providence	Erosion on 10S26 and 10S26A	Maintain roads
54447	Providence	Erosion on temp road extension of 10S26A	Stabilize erosion; design and construct new proposed temp road to avoid this problem
54441/54442	Providence	Road surface and stream crossing erosion	Maintain road and improve stream crossing

2.1.2.5. Roads and Landings

No new permanent road construction would be required to accomplish the proposed activities listed above. Temporary roads are generally short segments of approximately 0.1 to 0.2 miles in length constructed to access treatment units and log landings. Approximately 2.2 miles of existing temporary roads would be reopened and 0.26 miles of new temporary road would be constructed. These roads provide a temporary transportation link between the treatment area and the FS roads. Following completion of treatment activities, temporary roads are rehabilitated to a near natural condition and are blocked consistent with timber management and road BMPs to maintain water quality.

Road reconstruction would occur on approximately 14.5 miles to support access to treatment units without allowing for damage to resources. Activities may include rock and log removal, grading, and brush clearing. Plugged culverts would also be cleared. This type of reconstruction does not change the road standard or intended access.

Road maintenance would occur on approximately 34.9 miles of roads needed for access to treatment units. Some maintenance would be needed prior to Project completion, including repair of damage from wet weather planting traffic. Road maintenance activities would include roadside brushing, installation of waterbars or rolling dips, grading, cleaning ditches and culverts, and removing small trees and limbs that interfere with traffic and/or visible sight distance around curves.

Landings would be included in the commercial treatment units located at the end of the temporary road segments or adjacent to FS roads. Landings that already exist within the Project area would be utilized, although some may be enlarged or re-created to accommodate the removal of trees and/or biomass. All landings (new and existing) would meet BMPs and other direction for location, development, use and rehabilitation.

2.1.3. Alternative 3

Alternative 3 was developed to incorporate the request brought up during scoping to limit thinning to 12 inches DBH within the Project. A request from the Dinkey Collaborative to exclude herbicide use from the Project is also incorporated into this alternative.

Alternative 3 is a non-commercial funding action alternative which would limit the removal of trees throughout the Project to less than 12 inches DBH. Where fuel objectives allow, trees greater than 12 inches DBH that would otherwise be marked for removal would be felled and left in place or girdled to create snags. Where burns can be prescribed without pre-treating the vegetation, these areas would be identified and emphasized for prescribed fire treatment.

Alternative 3 involves a combination of manual, mechanical, and prescribed fire treatment methods in stands, plantation maintenance, watershed and riparian area treatments, road maintenance, and temporary road construction to accomplish the Project objectives. Vegetation treatments would cover the same amount of acres as alternative 2 (refer to Figure 3), however, only trees up to 12 inches DBH would be removed as mentioned previously. Fuels reduction treatments would be similar to alternative 2 (see alternative 2 for treatment descriptions and refer to Figure 4 and Figure 5). Herbicides would not be used in this alternative. Therefore, reforestation treatments and noxious weed eradication would not occur in alternative 3 (see Table 3). The treatments that are the same as alternative 2 cover the same amount of acres; the only difference would be that the volume of trees being removed would be less in this alternative. Table 3 below summarizes the treatments for alternative 3.

Table 3. Summary totals of proposed treatments for alternative 3 in acres.

Treatment	Acres
Restoration Thin	**887**
Ladder Fuels - mech	**654**
Ladder Fuels - hand	**29**
Plantation Maintenance	**36**
Fuel Treatments	**1873**
Tractor Pile	742
Grapple Pile	814

Treatment	Acres
Hand Pile	29
Mastication	68
Lop & Scatter	83
Crush & Brush	137
Prescribed Fire Treatments	**3886**
Burn Piles (tractor, grapple, hand)	1585
Jackpot Burn	15
Underburn	1248
Broadcast Burn	146
Reforestation Treatments	**0**
Site Prep (chem 1)	0
Release (chem 2)	0
Planting	0
Noxious Weed Eradication	0

2.1.4. Design Criteria Incorporated into the Action Alternatives

To minimize potential adverse impacts to resources in the area from this Project, the following design criteria are incorporated into the Project. They are broken into resource groups but many of these features can reduce impacts to other resources as well. Project-wide design criteria are applicable to the Project as a whole and are not resource specific. Design criteria that pertain to all action alternatives are listed first, followed by design criteria specific to the different action alternatives if applicable. All applicable SNF LRMP S&Gs are incorporated into the Project design. Those design criteria that are based on the SNF LRMP S&Gs are referenced with the S&G number. If a design criterion is based on an S&G that comes specifically from the SNFPA ROD, it is referenced as such. Some of the design criteria are based on scientific research or consultation, the professional opinion of specialists on how to move the Project towards the S&Gs, or prior experience that has proven that the criteria will protect the resource.

2.1.4.1. Design Criteria Common to All Action Alternatives

Project-Wide Design Criteria

1. Trees 30 inches DBH and larger would be retained throughout the Project area (S&G 6).
2. Thinning in plantations and other areas would be limited to periods when slash would be less likely to provide habitat to the Ips species of bark beetle (December to June) to reduce the

potential from insect attacks. These dates can be changed based on an evaluation of a certified silviculturist (S&G 117, Fettig et al. 2006, Integrated Pest Management [IPM] 1990)

The following design criteria (#3 - #11) are standard operations procedures for protecting resources during piling and firing operations. Most have been developed from generations of firefighting and prescribed burning and are considered BMPs by fire managers.

3. All burn piles would have a good base to keep the pile from toppling and would have enough distance between piles to prevent premature ignition during burning. Piles would be located so that burning would cause minimal damage to standing green trees. Depending on the size of the residual (leave) trees, this would be at least 20 feet from the bowl of any live tree.
4. If the green conifer slash must be piled following vegetation treatments, slash piles would be located in open, sunny locations outside of the dripline of leave trees and kraft paper may be used to protect an ignition point from wet weather. Slash piling would occur from July 1 through October 31 to enhance the drying of created slash and reduce the build-up of detrimental insect populations (except when restricted by a limited operating period [LOP]) (S&G 117, Fettig et al. 2006).
5. Burning would only be initiated on “burn days” designated by the SJVUAPCD when satisfactory wind dispersal conditions prevail (S&G 218).
6. Piles are typically ignited with drip torches, except within RCAs. Fire would be allowed to creep between piles while maintaining a burn intensity that would minimize tree bole scorch height or mortality of the retained trees and would be ignited using a pattern that allows animals to escape the fire. For example, one end of the pile would be lighted or an area would be left unignited to serve as an escape route.
7. To mitigate the impacts of prescribed fire to air quality, best available control measures (BACMs) would be employed as required under Section 190 of the Clean Air Act, as amended in 1990. The U.S. Environmental Protection Agency developed implementation strategies and BACMs for areas that are designated as in serious non-attainment for PM_{10} in 1992. Specific techniques to reduce fire emissions include the following:
    - Commonly used reduction techniques would be applied, such as burning units after harvest before new live fuels appear, burning in the springtime prior to “green-up,” burning when 1,000-hour fuel (woody debris larger than three inches in diameter) moistures are high, and burning when the duff is wet (after fall precipitation, or during winter and spring).
    - Avoidance techniques would be used, such as burning on cloudy days when the plume and residual smoke cannot be seen, burning during periods of atmospheric instability for better smoke dispersal, and burning during periods of low visitor use.
    - Techniques to optimize flaming combustion would be utilized, including burning piled fuels rather than broadcast burning, reducing the amount of soil in piles, and employing rapid ignition to create a high-intensity fire.
    - All activities would conform to the State Implementation Plan (SIP).
    - A full conformity analysis would be conducted, as required by the Clean Air Act and the SIP to assess whether the action produces less than the minimum emissions.
8. The following roads would be managed as strategic and tactical holding/ignition lines for prescribed fire operations and would be snagged prior to burn operations (National Wildfire Coordination Group (NWCG) 2004; FSH 7709.59, Ch.40; California State Public Resource Code 4291):

- Clarence Burn: FS roads 10S18, 10S02, and 10S404
- Soaproot Units: FS roads 10S04 and 10S05
- Rush and Little Rush Underburn Units: FS roads 10S43, 10S43X, and 10S02D
- Virginia Burn: FS roads 10S50 and 10S02

9. All other roads within prescribed fire burn boundaries may be used as secondary control lines (to be determined by burn boss during ignition operations). Snags may be felled as necessary if they pose a threat to firefighter safety at time of burn. Tagged wildlife trees would be protected using measures designed to reduce direct effects of prescribed fire and would be avoided to the extent possible.
10. Large woody debris created from hazard tree operations would be removed to increase efficiency of fire control operations and improve firefighter safety.
11. Larger trees would be protected during understory burning to maintain stand structures that would contribute to future habitat diversity.
12. Prior to implementing the Project near private lands, landlines would be flagged to ensure that innocent trespass is avoided (S&Gs 161 & 162).
13. Legal access on existing roads through private lands would be acquired before Project implementation (S&Gs 161 & 162).

General Terrestrial Wildlife

14. Four of the largest snags per acre would be retained (S&G 11).
15. At least five well-distributed logs would be maintained per acre as large woody debris representing the range of decomposition classes defined in the SNF LRMP (S&G 10).
16. Thinning around individual oaks would occur to increase oak crown and acorn production. To provide for oaks for wildlife needs, five to 35 percent of growing space devoted to oaks would be maintained. All decadent oaks throughout the stands would be retained within the limits appropriate for each forest type. Overtopping of decadent oaks would not be prevented. (S&G 66, SNFPA S&G 12 & 18 – 20).

The following design criteria (#17 - #20) would apply to the Deer Winter Range within the Project area as covered under the North Kings deer herd management plan (Bertram 1984):

17. Where it exists, 40 to 50 percent brush cover would be retained. Where south slope cover is lacking, additional north slope cover would be retained to compensate.
18. Where it exists, roadside screening cover would be retained to improve cover where it is deficient (S&G 48).
19. Tree stocking densities in plantations on key winter range areas would be minimal to prolong understory life. Two hundred trees per acre or fewer would be suggested (Bertram 1984).
20. Prescribed burning would be done in fall to stimulate non-sprouting shrub species, and in spring for sprouting shrub species.

Special Status Terrestrial Wildlife

21. All treatment units within one-quarter mile of a Northern goshawk nest site during the breeding season would have an LOP prohibiting vegetation treatments from February 15 to September 15, unless surveys confirm that goshawks are not nesting (SNFPA S&G 76).

22. Breeding season LOP restrictions for goshawk may be waived, where necessary, to allow for use of early season prescribed fire treatments (SNFPA S&G 79).
23. All treatment units within one-quarter mile of an active great gray owl nest stand during the nesting period would have an LOP prohibiting vegetation treatments and road construction from March 1 to August 15 (SNFPA S&G 83). The LOP would not be needed unless an owl is found, in which case the nest stand would get a one-quarter mile PAC established around it (per District wildlife biologist).
24. In meadow areas of great gray owl PACs, herbaceous vegetation would be maintained at a height commensurate with the site capability and habitat needs of prey species (SNFPA S&G 84).

The following design criteria would be implemented to protect the Pacific fisher and its habitat:

25. Pacific fisher den site buffers would have a LOP prohibiting vegetation treatments from March 1 to June 30, as long as habitat remains suitable (SNFPA S&G 85).
26. Key large tree denning structures needed by Pacific fisher would be retained to the extent possible (to achieve desired conditions for fisher as stated in the SNFPA ROD 2004).
27. Within Pacific fisher den site buffers, prescribed fire may be used to treat fuels if no other reasonable alternative exists (SNFPA S&G 86).
28. Within the Southern Sierra Fisher Conservation Area (SSFCA), prior to vegetation treatments, design criteria such as prescribed burning techniques would be implemented to protect important habitat structures as identified by the wildlife biologist. Important habitat structures include large diameter snags and oaks, patches of dense large trees (one-quarter to two acres in size), key large tree nesting structures, small understory trees, and coarse woody material. Mechanical treatments would be used when appropriate to minimize effects on preferred fisher habitat elements (SNFPA S&G 90).

The following design criteria would be implemented to protect the California spotted owl and its habitat:

29. All treatment units within one-quarter mile of the activity center during the California spotted owl breeding season would have a LOP prohibiting vegetation treatments from March 1 to August 15, unless surveys confirm that owls are not nesting (SNFPA S&G 75).
30. Breeding season LOP restrictions for spotted owl may be waived, where necessary, to allow for use of early season prescribed fire treatments (SNFPA S&G 78).
31. Within HRCAs outside WUI defense zones, at least 50 percent canopy cover averaged within the treatment unit would be retained (SNFPA S&G 7).
32. Outside of HRCAs and WUI defense zones, at least 50 percent canopy cover would be retained within the treatment unit. Where canopy cover must be reduced below 50 percent, then at least 40 percent canopy cover averaged within the treatment unit would be retained (SNFPA S&G 7).
33. Mechanical treatments may be conducted to meet fuels objectives in PACs located in WUI defense zones. In PACs located in WUI threat zones, mechanical treatments are allowed where prescribed fire is not feasible and where avoiding PACs would significantly compromise the overall effectiveness of the landscape and fire and fuels strategy. Mechanical treatments should be designed to maintain habitat structure and function of the PAC (SNFPA S&G 72).
34. Mechanical treatments would not occur within a 500 foot radius buffer around a spotted owl activity center within a designated PAC. Prescribed burning however is allowed within the 500 foot radius buffer (SNFPA S&G 73).

35. Within PACs located outside the WUI, stand-altering activities would be limited to prescribed fire activities to reduce surface and ladder fuels. In forested stands with overstory trees 11 inches DBH and greater, prescribed fire treatments would be designed to have an average flame length (the average length of a flame at a given point – expressed in feet) of four feet or less (SNFPA S&G 74).
36. Hand treatments, including handline construction, tree pruning, and cutting of small trees (less than six inches DBH) may be conducted prior to burning as needed to protect important elements of owl habitat (SNFPA S&G 73 & 74).

Watershed & Riparian

37. Applicable BMPs would be incorporated into all Project activities and implemented to protect water quality (S&G 124). Specific BMPs and the activities to which they apply are listed in Appendix B.
38. Streamside Management Zones (SMZs), Riparian Management Areas (RMAs), and RCAs, as identified in the SNF LRMP, would be applied to delineate areas where riparian habitat considerations would be emphasized (S&G 70; SNFPA S&G 91). SMZ, RMA, and RCA widths are listed in Table 4. On steep slopes, SMZs are extended by three feet for each percent over 30 percent (for example, the SMZ would be 15 feet wider than the minimum width on a 35 percent slope). All guidelines and restrictions for these areas as established by the district hydrologist and aquatic biologist and defined in the SNF LRMP would be followed.

Table 4. RCA, SMZ, and RMA widths (USDA FS 1989, USDA FS 2004).

<table>
<tr><th>Feature Type</th><th>RCA Width</th><th>Stream Class</th><th>SMZ Width</th><th>RMA Width</th><th>Corresponding GIS Layer Stream Order</th></tr>
<tr><td>Perennial Streams</td><td>300 feet</td><td>I *</td><td>At least 100 ft</td><td>100 feet</td><td>3+</td></tr>
<tr><td rowspan="4">Seasonally Flowing Streams (includes ephemeral streams)</td><td rowspan="4">150 feet</td><td>II</td><td>At least 75 ft</td><td rowspan="4">N/A</td><td>2</td></tr>
<tr><td>III</td><td>At least 50 ft</td><td>-</td></tr>
<tr><td>IV</td><td>At least 25 ft</td><td>1</td></tr>
<tr><td>V</td><td>None required</td><td>-</td></tr>
<tr><td>Streams in Inner Gorge</td><td>Top of inner gorge</td><td colspan="4">Varies</td></tr>
<tr><td>Special Aquatic Features (fens, bogs, springs, seeps, lakes, ponds, wetlands, etc.)</td><td rowspan="3">300 feet</td><td>N/A</td><td>N/A</td><td rowspan="2">100 feet</td><td rowspan="3">Identified on GIS layers or in the field</td></tr>
<tr><td>Perennial Streams with Riparian Conditions extending more than 150 feet from edge of streambank</td><td rowspan="2">I</td><td rowspan="2">At least 100 ft</td></tr>
<tr><td>Seasonally Flowing streams with riparian conditions extending more than 50 feet from edge of streambank</td><td>N/A</td></tr>
</table>

39. In areas with known CWE concerns where tractor piling is required to achieve treatment objectives, all SMZ widths would be increased by 25 feet (Class IV = 50 feet; Class III = 75 feet; etc.), plus the slope adjustments described in Sierra Supplement No. 1.
40. Any seeps, springs, fens, and/or wet areas discovered during Project implementation that are not already identified on Project analysis maps would be treated as perennial areas with 300 foot RCA and 100 foot SMZ no equipment buffers, unless otherwise classified by the District hydrologist or aquatic biologist (to implement S&G 70, 71, 73 and 124, BMP 1.8, and SNFPA S&G 91 in cases where incomplete data did not identify all areas needing protection).
41. New or replacement culverts would be sized to accommodate the 100-year flow, including expected sediment and debris, and designed to minimize the potential for stream diversion onto the road (SNFPA S&G 70).

All WIN sites would be coordinated with the District aquatic biologist for aquatic/riparian species or habitat occurrences at or around stream crossings. The following design criteria would apply to activities for WIN site #54381 (FS road 10S04 Rush Creek crossing improvement) (refer to aquatic species section for species specific design criteria):

42. All designs and improvement recommended for the stream crossing improvement would be coordinated with the District aquatic biologist and hydrologist and accepted prior to finalization.
43. Any removal of vegetation outside of the roadbed would be approved by the District aquatic biologist.
44. Bank destabilization or watershed issues created by Project activities would be repaired prior to the start of the first winter season.
45. If necessary, silt fencing would be installed to prevent or reduce sediment from entering the stream channel.
46. Fill materials would be approved prior to use.
47. Operations would cease for 24 hours after rainfall greater than 0.1 inches.
48. Removal of fill materials would be done after units have been harvested if it is causing stream degradation or downstream flow reduction.

General Aquatics

49. Riparian vegetation would not be cut during Project activity unless approved by the District aquatic biologist (S&G 37 & 69, SNFPA S&G 92, 96, 101, 103, 105, and 111).
50. Any discovery of amphibians or reptiles (e.g. frogs, toads, salamanders, and turtles) during Project sale preparation and implementation would be reported to the District aquatics biologist immediately (compliance with FS goal: species viability, plant and animal community diversity, SNFPA ROD, p. 32).
51. If newly listed or unknown occurrences of federally listed T & E, proposed (P), candidate (C), or FS sensitive (FSS) aquatic species are found within the affected Project area during sale preparation or implementation, additional species protection measures may be needed (Endangered Species Act, SNF LRMP compliance).
52. To ensure that management activities that can reduce tree canopy cover within RCAs do not adversely affect water temperatures necessary for local aquatic- and riparian-dependent species assemblages, canopy cover would be maintained at 80 percent within the SMZ (or at existing conditions if canopy cover is less than 80 percent) and at 60 percent within the remaining RCA. (SNFPA S&G 96).

53. Stream crossing structures would not create barriers to upstream or downstream passage for aquatic-dependent species (S&G 101).
54. Direct lighting of riparian vegetation would be avoided. No direct lighting within SMZs. However, prescribed fires would be allowed to back into riparian areas (SNFPA S&G 109, BMP 6.3).
55. When broadcast burning in RCA/SMZ areas, ignition would be stopped within 100 feet of the stream or aquatic feature and fire would be allowed to back down into the area.
56. Helicopter “ping pong ball” lighting within RCAs would not be allowed.
57. Dozer or hand fire line construction within RCAs would follow species specific design criteria and would adhere to BMPs outlined in the District hydrologist report.
58. Fire lines necessary within SMZs would cross perpendicular to streams, follow the natural landscape contour, and be hand cut unless consulted by the district hydrologist or aquatic biologist. Fire lines would be designed and constructed to reduce sediment entry into channels and would be waterbarred. At a minimum, a waterbar should be placed on either side of each stream crossing.
59. Fuels and other toxic materials would not be stored within RCAs except at designated administrative sites and sites covered by a Special Use Authorization (S&G 99, BMP 2.11).
60. Refueling of chainsaws or other equipment within RCAs would use the following guidelines (S&G 69 & 75, SNFPA S&G 92 & 99, achieving SNFPA ROD desired conditions for species viability – minimizing impacts):
    - Do not refuel within an RCA unless there are no other alternatives. Any locations within an RCA used for refueling must first be approved by the District hydrologist or aquatic biologist.
    - Site specific refueling area plans for difficult terrain within the Project area can be developed for refueling within an RCA if no other options are available (i.e. use of a spill pad under chainsaw while refueling within RCA).
    - If site specific refueling area plans are developed, at a minimum, refueling must take place outside of the SMZ (BMP 2.11).
    - Any spills (regardless of amount) would be cleaned up immediately. Refueling would occur on a spill pad to avoid soil and water contamination.
    - Ensure spill plans are reviewed and up-to-date (S&G 99, BMP 7.4).

The following design criteria would be implemented within SMZs or RCAs associated T&E, P, C, or FSS occupied aquatic/riparian species habitat (additional measures may apply for occupied habitats beyond the SMZs/RCAs):

61. Hand piles within occupied aquatic species habitat would be located outside of SMZs unless approved by the District aquatic biologist or a site specific plan is developed for that unit. See specific species guidelines for identified buffers in occupied habitat.
62. Trees within SMZs of occupied TES habitats would not be removed (drop and leave) unless the area is field reviewed for aquatic species habitat prior to Project work and approved by the aquatic biologist or unless the work can be accomplished from an existing FS roadside only and no soil disturbance occurs while implementing activities. If soil is disturbed during tree removal, Project activities in the SMZ would stop immediately and rehabilitation work would be completed after consultation with the District aquatic biologist and hydrologist.

63. End-lining, or skid trail construction in the SMZs of stream channels would not be allowed (BMPs 1.8, 1.19).
64. New landing construction or temporary road construction would not be allowed within SMZs (S&G 37, 69, 78 and 79, SNFPA S&G 92, 96, 99, and 100). Any new landing sites proposed within an RCA would follow BMP 1.12 and would be reviewed by the hydrologist and aquatic biologist.
65. For use on existing landings within RCAs or SMZs, the "Flow Chart" (Edinger 2001) would be followed. Existing landings located within an RCA or SMZ would be field reviewed and approved by the District hydrologist and aquatic biologist prior to use.
66. All cull and other materials would be removed from approved landings located within SMZs of meadows or perennial streams (S&G 37 and 69, SNFPA S&G 92).
67. Temporary roads would not be constructed within SMZs unless approved by the District hydrologist and aquatic biologist.
68. Skid trails, landings, and temporary roads would be designed to eliminate the potential to capture surface run-off and then deliver sediment into or divert stream flow from occupied or suitable habitat for aquatic/riparian species (SNFPA S&G 92, 100, 113, and 118, BMP 1.10).
69. Skid trails, landings, temporary roads, and end-lining activities would not cross through or within 500 feet of any stream, waterbody or meadow with occupied habitat for federally listed T&E or within 100 feet of C or FSS aquatic species habitat (S&G 69, SNFPA 92, 100, and 118).
70. Skidding and end-lining would not be allowed in or across meadows, perennial, or intermittent streams (S&G 37, 69, 75, 77, 78, and 79, SNFPA S&G 92, 100, and 118).
71. Skid trails, landings, and temporary roads, would be properly cross-ditched after use or before winter precipitation, whichever comes first. These activities would also be slashed, ripped or mulched if necessary (BMP 1.16 and 1.17).
72. Any soil damage within RCAs as a result of skidding/end-lining would be rehabilitated.

If stream drafting is necessary, the following design criteria would be implemented (SNFPA S&G 92, 96, 101, 103, and 110, BMP 2.5):

73. Water drafting candidate sites should be selected by the sale administrator and approved by the hydrologist and aquatic biologist prior to use (BMP 2.5).
74. Water drafting sites should be at least 500 feet to 0.6 miles away from occupied aquatic species habitat (as determined by the aquatic biologist).

The following requirements would be monitored by the hydrologist or aquatic biologist:

75. Drafting sites would be visually surveyed for frogs and their eggs before drafting begins (SNFPA S&G 92 and 110).
76. A screened intake device and pumps with low entry velocity and suction strainers with screen less than two millimeters (1/8 inch) in size would be used to minimize removal of aquatic species, including juvenile fish, amphibian egg masses and tadpoles, from aquatic habitats (SNFPA S&G 110).
77. The suction strainer would be inserted close to the substrate in the deepest water available and placed in a canvas bucket to avoid substrate and aquatic species disturbance (SNFPA S&G 92 and 110).
78. Drafting would not be allowed unless immediate downstream discharge from drafting site is maintained at 1.5 cubic feet per second (cfs) or greater (S&G 43, BMP 2.5).

79. Water drafting would be permitted to remove no more than 50 percent of any stream's ambient discharge that is over 1.5 cfs (S&G 43, BMP 2.5).
80. Where treatments are proposed in habitat for T, E, C, or FSS aquatic and riparian species, only water would be used for dust abatement within RCAs (S&G 69, SNFPA S&G 92 and 99).

Special Status Aquatic Wildlife

The following design criteria would be implemented to protect the Western pond turtle (FSS species) and its habitat:

81. All activities within 325 feet of any stream channel identified as Western pond turtle occupied habitat would only occur between June 15 and October 15 (or first winter rain) to protect nesting, breeding, and overwintering sites. This also applies to WIN site treatments, unless approved prior to treatments by the District aquatic biologist. If Project activities need to occur in a unit outside of the LOP, the District aquatic biologist would be consulted for on-site surveys or additional measures needed to ensure species viability.
82. When possible, equipment and soil disturbance in units that overlap occupied terrestrial habitats would be minimized for the protection of underground Western pond turtle nests.
83. Mechanical equipment would not be allowed off of already established roads (FS roads 10S04, 10S04A, and 10S430) within 325 feet of Rush Creek and associated tributaries.
84. A strategy for piles that would need to be located within 325 feet from perennial streams identified as occupied habitat for the Western pond turtle along Rush Creek, Big Creek, or tributaries of Big Creek would be consulted with the District aquatic biologist.
85. Endlining and skidding would not be allowed within 325 feet of Rush Creek and associated perennial streams unless location is surveyed for potential nesting habitat for Western pond turtle prior to Project activities.
86. If Western pond turtles are located in the Project area during implementation, they would be gently moved into a similar and safe place nearby (i.e. stream channel) in the direction they were traveling. The District aquatic biologist would be notified of any sightings.

In addition to the design criteria for activities within 325 feet of occupied stream habitat, the following would apply to prescribed fire activities within this area:

87. Timing, special needs, new TES species occupancy information, and sensitivity of prescribed fire activity would be coordinated with District specialists prior to implementation.
88. Strategies that are employed must be weighed out to ensure the outcome would benefit the Project as a whole both short-term and long-term (i.e. implementing handline in or near a riparian zone in order to protect larger scale damage to the riparian zone or forest land).
89. Large gatherings of personnel and equipment would be avoided in riparian zones.
90. National fire retardant guidelines would be followed for perennial streams occupied with TES aquatic species.

The following design criteria would apply to activities for WIN site #54381 for protection of the Western pond turtle during those activities (additional measures may be added during Project implementation if necessary):

91. Project activities would occur during the fall (September to mid-October). If access is needed prior to September, field review of stream flow conditions would be conducted to evaluate for appropriateness of timing and additional effect to habitat and species.

- At a minimum, Project activities can occur within October 15th to June 15th to protect dispersal, breeding, nesting, and overwintering habitats.

92. Prior to daily Project activities, WIN site would be surveyed for any individuals utilizing the crossing habitat. Individuals would be moved upstream or downstream to a safe location. If individuals are found directly within the Project area during daily work, activities would be stopped until individuals can be moved by the District aquatic biologist or qualified person to a safe location.
93. If water diversion is necessary during Project activities, selection and approval of diversion and outflow locations would be coordinated with the District aquatic biologist.
    - If pumps are needed to pump water from diversion around the Project area to a downstream location, all drafting requirements above would be followed. On a daily basis, diversion pool would be surveyed to ensure no Western pond turtle individuals have moved into the area. Individuals would be relocated to a safe place upstream or downstream in a similar habitat.
94. Steam channel dewatered for Project would be kept to a minimum distance.
95. Western pond turtle individuals located in stream habitat temporarily dewatered for Project work would be relocated by the District aquatic biologist or qualified person to an approved location.
96. De-watering of the main channel (Rush Creek) outside of the approved crossing area would not occur downstream of the crossing, even temporarily.
97. All equipment would be stored at a minimum of 325 feet away from Rush Creek unless site is approved by the District aquatic biologist and would be clean and free of mud and dirt prior to bringing to Project location.
98. Equipment would not be allowed to turn within 100 feet of Rush Creek (back and forth only) and would not be allowed off the road bed unless approved by the District aquatic biologist.

Botanical Resources and Invasive Species

99. Any discovery of sensitive or special interest botanical species during Project sale preparation and implementation would be reported to District botanist (S&G 68).
100. If newly listed or unknown occurrences of federally listed T, E, P, C, or FSS plant species are found in the Project area during sale preparation and implementation, additional species protection measures may be needed (Endangered Species Act, S&G 68).
101. Impacts to known occurrences of sensitive plants within the Project area would be avoided. The contract administrator or Project manager would consult with FS botanical staff prior to Project implementation to ensure appropriate buffers and flagging are in place (S&G 67 and 68).
102. Pile burning would not be conducted in sensitive plant occurrences (S&G 67 and 68).
103. To protect sensitive plant species that grow in rock outcrops and associated gravel soils, the following guidelines would be followed (S&G 67 and 68; based on professional experience derived from working with maintaining species):
    - Trees would not be felled and equipment or vehicles would not be driven on rock outcrops or on thin, sandy or gravelly soils.
    - The District botanist would be consulted before cutting hand line through shallow, gravelly soils.

- Hand thinning of shrubs on rock outcrops or associated gravelly soils would be avoided unless approved by the District botanist.
- Temporary road construction would not be allowed through areas of thin, gravelly soils until plant surveys of the proposed routes are complete, or the District botanist has approved the road location.

104. All off-road equipment used on this Project would be washed before moving into the Project area to ensure that the equipment is free of soil, seeds, vegetative material, or other debris that could contain or hold seeds of noxious weeds (SNFPA S&G 39).
105. Staging areas for equipment, materials, crews, or landings would be prohibited in areas with weed infestations. When working in known weed infested areas, equipment would be cleaned before moving to other areas which do not contain noxious weeds. (SNFPA S&G 40).
106. Areas with weed infestations would be avoided during piling operations. (SNFPA S&G 39, 40, and 41).
107. Weed-free mulches and seed sources would be used. All activities that require seeding or planting would utilize locally collected native seed sources when possible. Plant and seed material should be collected from or near the Project area, from within the same watershed, and at a similar elevation when possible. Seed mixes must be approved by a FS botanist, noxious weed coordinator, or ecologist (Developing MOU with state of California).
108. Weed infestation areas identified before or during Project implementation, within the treatment units or along travel routes near the treatment units, would be hand treated or “flagged and avoided” (SNFPA S&G 40).

Geology and Soils

109. A 100 foot wide buffer of 100 percent soil cover would be left below large rock outcrops to avoid potential runoff generated by these areas that can cause accelerated erosion on soils down slope (FSM 2500, Ch. 2550, 2010).
110. Mechanical equipment operations would be conducted when the soil is sufficiently dry in the top 12 inches to prevent unacceptable loss of soil porosity (soil compaction). Field checking by a soil scientist would be done to determine if operations could continue under moist soil conditions. Ninety percent of the soil porosity over 85 percent of an activity area (stand) found under natural conditions would be maintained. (FSM 2500, Ch. 2550, 2010).
111. Skid roads and trails would be subsoiled and waterbarred in areas where soil compaction exceeds 15 percent of a treatment area (FSM 2500, Ch. 2550, 2010).
112. Mechanical operations would be limited where sustained slopes exceed 35 percent, except where supported by on-the-ground IDT evaluation (S&G 125).
113. Over all treatment areas, a 50 percent soil cover would be maintained. Where shrub species predominate, they would be crushed before piling to create small woody fragments left scattered over the site for soil cover and erosion protection (S&G 130).
114. Road surface stabilization (gravel) would be provided for on roads over five percent grade that are located on sensitive soils, including Auberry family, Holland family, and Ultic Haploxeralf soils (S&G 129) and are affecting soil productivity and/or water quality.
115. Tractor piling in watersheds with CWE concerns would be limited and a grapple piler would be used, especially on slopes greater than 25 percent (S&G 120).

Cultural Resources

Procedures from the First Amended Regional Programmatic Agreement Among the USDA Forest Service, Pacific Southwest Region, California State Historic Preservation Officer, and Advisory Council on Historic Preservation Regarding the Process for Compliance with Section 106 of the National Historic Preservation Act for Undertakings on the National Forests of the Pacific Southwest Region (Regional PA) would be utilized for the management of cultural resources within the Project area. Cultural resources shall be protected from those Project activities which can adversely affect the significant values of the property through implementation of Standard Protection Measures (Attachment B) of the Regional PA. Site specific protection measures are described in the cultural resources report for this Project (Marsh 2012).

116. Cultural resource sites would be excluded from all Project activities that could result in ground disturbance within their boundaries (e.g. the use of ground based mechanical equipment, piling and burning). Material would be allowed to be cut and removed by hand from within the boundaries of cultural resource sites.

117. Ground disturbing activities would be avoided in historic properties. Archaeological resources would be excluded from proposed Project activities that could result in ground disturbance within their boundaries (i.e. use of ground based mechanical equipment, planting, piling and burning, fire line construction, road construction, etc.).

118. Certain non-disturbing activities, those that lack the potential to adversely affect the character of historic properties, would be allowed within site boundaries. These include:
    - Archaeological resources may not be “at risk” of effects from prescribed fire use. The standard resource protection measures would be applied only to those historic properties defined as “at risk” from the use of prescribed fire treatments.
    - Mechanical shredding or removal of fuels inside of site boundaries with an articulated boom shredder/harvester would not affect the archaeological materials, provided the tracked or wheeled equipment stays outside of the delineated site boundary and the machine head does not contact the ground surface or site features. Removal of fuels by hand (manual thinning with chainsaws) would not affect archaeological materials.

119. Traditional cultural properties, locations of contemporary Native American gathering, and other such non-archaeological cultural resources identified through consultation with Native American tribes, individuals, and other interested parties would be protected through avoidance by Project activity, or managed through Project implementation and consultation to benefit the resource. For example, planned prescribed fire can have positive effects to regenerate growth in certain plant species used by Native Americans in basketry or traditional food preparation.

120. In the event of inadvertent effects of new discovery during implementation, the SNF would comply with the stipulations of the Regional PA.

Engineering

121. All FS roads would be maintained to standards established in the FSH 7709.58. Road maintenance and reconstruction activities would be performed to support Project access needs. Drainage structures would be designed to be functional and stable to prevent potential resource damage and degradation of water quality. (S&G 78, 79, 124, and 206, BMPs 2.3 and 2.4).

122. A final field review of Project roads would be performed to determine reconstruction needs prior to Project activities. Where economically feasible, aggregate would be placed on existing native surface roads located in areas with High and Very High Soil Erosion Hazard ratings.

Aggregate would be required on road slopes greater than five percent in areas with these ratings. (S&G 129).

123. Upon completion of use, all temporary roads required for unit access would be closed; culverts would be removed, landings would be ripped and ditched, waterbars would be constructed, the entrance to the road would be blocked with a log and dirt berm and disguised with brush to discourage additional traffic (BMPs 1.16, 1.17, 1.19, 2.3, 2.7, 2.13).

Visual Resources

The following design criteria developed for scenery would aid in achieving the SNF LRMP VQO of Modification for the Project area and would be applied to areas highly visible (i.e. within view of a 300 foot distance) to Bretz Mill Campground, private property, Peterson Mill Road, and FS roads 10S02, 10S17, and 10S18, unless otherwise noted:

124. Fire lines would follow natural contours whenever possible. Underburning operations would be modified to minimize the amount of overstory mortality in consultation with the Forest landscape architect. Islands of unburned vegetation would be retained in some areas to increase visual interest and attract wildlife. The edges of the islands would be irregularly shaped, feathered and undulated to create a near-natural appearance.
125. Tree stumps would be cut to a maximum of six inch heights from the uphill side or as low as possible, except along FS road 10S17.
126. Where feasible, burn piles would be located in areas where they would not be highly visible from the areas listed above. Piles in these areas would burn with more than 90 percent consumption. If 90 percent consumption is not reached (and the remaining fuels still meet the fuels objectives), the remnant slash would be scattered throughout the site. Efforts would be made to burn these piles within three years during low-use recreation season to reduce impacts to forest visitors.
127. Where feasible, landings would be located in areas where they would not be highly visible from the areas listed above. When possible, landing sizes would be minimized and restricted to existing openings. Where landings are visible, efforts would be made to remove the landing piles within three years during low-use recreation season to reduce impacts to forest visitors.
128. In areas where skid trails and/or fuel break lines are highly visible, they would be rehabilitated so that they are not visually evident within three years.

2.1.4.2. Design Criteria Applicable to Alternative 2

The following design criteria (#1- #4), developed by the District silviculture assistant and wildlife biologist, would only be applied to snags less than 30 inches DBH that occur in areas being treated with the restoration thinning prescription. These design criteria would not apply to hazard trees; all trees considered hazards to improvements, human safety, or private property would be removed, regardless of size.

1. Within WUI defense zones, four of the largest snags per acre would be retained. In the case where there is a group of large snags, four of the largest snags within the group would be retained per acre.
2. Within WUI threat zones, five of the largest snags per acre would be retained. In the case where there is a group of large snags, five of the largest snags within the group would be retained per acre.

3. In areas outside of the WUI, six of the largest snags per acre would be retained. In the case where there is a group of large snags, six of the largest snags within the group would be retained per acre.
4. In addition to the snag retention levels listed above, additional snags with the following properties would be retained: evidence of known or potential cavities; broken top (for snags at least 15 inches DBH at the break and at least 30 feet tall); mistletoe or other abnormal witches broom formation or other unusual tree growth formations due to disease or insect damage; teakettle branches; forked top; or broken large branches.
5. Reforestation stocking would meet standards described in the SNF LRMP (S&Gs 101, 102, 107 – 110). The release of existing plantations would meet the growth and stocking standards outlined in growth and yield tables (Oliver and Powers 1978).
6. Reforestation treatments would occur in openings deemed appropriate on the ground throughout the Project area. Areas where other design criteria do not allow the use of herbicides, but herbicide is thought to be necessary for successful reforestation, are not appropriate for reforestation treatments.

Herbicide Use

7. No herbicide spraying would occur within SMZs or RMAs (SNFPA S&G 97).
8. Spraying would be limited to periods when rain events are not predicted in the near future to allow for maximum absorption into soils (BMP 5.7).
9. Herbicide applications for treatment of vegetation (site preparation and release) and noxious weed control may not affect historic properties where the application of herbicides does not have the potential to affect access to or use of resources by Native Americans.

2.1.5. Comparison of Alternatives

This section provides a summary of the effects of implementing each alternative. Information in Table 5 is focused on activities and effects where different levels of effects or outputs can be distinguished quantitatively or qualitatively among alternatives.

Table 5. Comparison of alternatives for the Project.

	Alternative 1 (No Action)	**Alternative 2 (Proposed Action)**	**Alternative 3**
	Fire and Fuels (modeled for 2022)		
Reduces risk of life and property and Improves effectiveness of fire suppression and fire fighter safety :	No	Yes	Treatment benefits last less than 10 years
<4' flame lengths:	1966 acres	2860 acres	3005 acres
Fire Severity:	No change from existing condition	Low severity increases; Moderate to high severity decreases	Low severity increases; Moderate to high severity decreases the first 10 years then returns to above pre-treatment levels
Low	2637 ac	3720 ac	3388 ac

	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3
Moderate	2588 ac	2172 ac	2086 ac
High	1767 ac	1104 ac	1522 ac
Fire type:	No change from exiting condition	Crown fires reduced in timbered stands	Crown fires reduced in timbered stands slightly more than alternative 2
Active Crown Fire	207 ac	64 ac	91 ac
Passive Crown Fire	1325 ac	908 ac	940 ac
Conditional-surface Fire	208 ac	101 ac	112 ac
Surface Fire	5181 ac	5924 ac	5853 ac
Vegetation and Silviculture			
Largest size tree proposed for thinning treatments:	N/A	30 inches DBH	12 inches DBH
Commercial volume of timber removed in thousand board feet (MBF):	0	1655 MBF	165 MBF
Total Trees per acre removed:	0	132	121
Total Trees per acre after harvest (residual):	467	335	346
Trees per acre 0 - 10" DBH	415	286	294
Trees per acre 10 - 20" DBH	41.6	38.4	41.2
Trees per acre 20 - 30" DBH	9.6	8.9	9.6
Trees per acre > 30" DBH	1.5	1.5	1.5
Terrestrial Wildlife			
Pacific fisher suitable habitat = 3,556 acres	0	27 PlanIDs being treated that occur in suitable habitat (<1% suitable habitat)	Same as alternative 2
California spotted owl suitable habitat = 3,556 acres	0	1619 acres of nesting habitat 1937 acres of foraging habitat	Same as alternative 2
Watershed/Hydrology/Soils			
Water Quantity/ Flows	No change from existing condition	No measurable changes	Same as alternative 2

	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3
Water Quality	Sedimentation is a concern in lower gradient stream reaches, especially in Big Creek and Rush Creek	Sedimentation could increase slightly in the short term (1-3 years) but may decrease in Big Creek over time (3-5 years)	Same as alternative 2
Stream Channel Shape and Function	Sensitive stream reaches are prone to erosion from storm runoff	Sensitive stream reaches could respond to even small increases in sediment delivery from hillslope treatments	Same as alternative 2
Effects of Herbicide Use	No herbicide use, thus no effects	Up to 123 acres in RCAs, 30 acres in SMZ/RMA, but no impacts to water quality are expected	Same as alternative 1
Cumulative Watershed Effects	Up to 23% of surveyed roads are hydrologically connected to streams and contribute to increased sediment delivery, peak flows, and in-channel erosion. Headcuts may progress upstream at two WIN sites Eight subdrainages are over the lower TOC; one of them is over the upper TOC	Reconstruction and maintenance of almost 50 miles of roads would minimize hydrologic connectivity, reduce sediment delivery, and possibly decrease V* in Big Creek over time. Two WIN sites with headcuts would be repaired. 12 subdrainages are over the lower TOC, 11 with Low risk to beneficial uses resulting from Possible CWEs with Minor consequences, one with Very Low risk resulting from Unlikely CWEs with Minor consequences	Same as alternative 2
Aquatic Resources			
	Acres of suitable habitat being treated		
Foothill yellow-legged frog suitable habitat = 1,786 acres	0	504 (28 %)	Same as alternative 2
Western pond turtle suitable habitat = 3,397 acres	0	938 (28%)	Same as alternative 2

	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3
Botany			
	Acres being treated		
TES Plants occurrences = 186 acres	0	34	Acres the same as alternative 2, however effects reduced due to the reduction of intensity of treatments in alternative 3 (i.e. no herbicide use and reduced intensity in vegetation and fuel treatments)
Noxious weed occurrences = approx. 15 acres	0	15	Since no herbicide use proposed, noxious weed s would not be treated in alternative 3

2.2. Alternatives Considered but Eliminated From Detailed Study

This section summarizes the alternatives considered but eliminated from detailed study along with the rationale for not analyzing these alternatives in detail.

Federal agencies are required by NEPA to thoroughly explore and objectively evaluate all reasonable alternatives and to briefly discuss the reasons for eliminating any alternatives that were not developed in detail (40 CFR 1502.14). Public comments received in response to the proposed action provided suggestions for alternative methods for achieving the purpose and need. Based on NEPA case law, alternatives can be eliminated if the proposed alternative 1) does not achieve the purpose and need; 2) has substantially similar consequences as alternatives considered in detail; 3) is not significantly distinguishable from alternatives already being considered; 4) is infeasible; 5) is ineffective; 6) is inconsistent with basic policy objectives for the action; or 7) if the existing range of alternatives sets forth alternatives necessary to permit a reasoned choice.

Public comments and internal scoping that suggested alternatives or components of an alternative be considered but were subsequently eliminated from detailed study are described below. The explanation for the elimination of the alternative from further full analysis is also included.

2.2.1. Prescribed Fire Only Alternative

During scoping, a request to analyze an alternative where vegetation management would be limited to prescribed fire without prior treatment was raised. This alternative was discussed during collaboration with the DLRP Technical Work Group and a summary is included in the Project record. A prescribed fire only alternative would not meet the purpose and need for the Project for the following reason:

The purpose and need proposes to protect adjacent landowners and private property from the effects of wildfire. Due to the risk of fire escaping fire lines in the Providence Creek portion of the Project, prescribed fire underburning would not be used as a restoration tool. A private subdivision of 35 cabins and summer homes is located directly upslope and adjacent to this portion of the Project; the use of prescribed fire underburning as a treatment option poses a risk the HSRD fire management staff feels is too high to undertake.

The HSRD's experience with prescribed fire in this portion of the Project has resulted in fire escaping from unit boundaries three times over a 15 year period (projects include Big Sky, 10S18 FRP, and Bretz Thinning). These escapes are the result of unusually strong, warm and unpredictable nighttime winds that swirl cross slope in this bowl shaped canyon.

The inability to fully treat fuels in the WUI defense and threat zone under this alternative means the purpose and need for reducing fire hazard and fuel loading would not be met in this alternative.

This alternative was eliminated from detailed analysis both because it failed to meet the purpose and need of the Project and because of the risk of unacceptable consequences to the public and private property.

3.0. Affected Environment and Environmental Consequences

This section focuses on the affected environment and environmental effects (direct, indirect, and cumulative) for those resources that the Project intends to improve from the existing conditions (needs for the Project, section 1.4) and those resources that received key issues from interested parties during scoping (see section 1.8). Certain resource areas were analyzed because they were a concern or recommendation from the public during scoping (but not an issue). These resource areas are briefly summarized following this introduction because they were not brought up as an issue, have no effects due to Project design, or are outside the scope of this analysis.

This section summarizes the physical, biological, social and economic environments of the affected Project area and the potential changes to those environments due to implementation of the alternatives. It also presents the scientific and analytical basis for comparison of alternatives presented in section 2.1.5. Some resource sections will discuss some of the same topics and may seem repetitive. However, certain topics (e.g. fire severity, basal area, herbicide use) apply to multiple resources and are analyzed as to how they relate to that specific resource.

Direct environmental effects are those occurring at the same time and place as the initial cause or action. Indirect effects are those that occur later in time or are spatially removed from the activity, but would occur in the foreseeable future. Cumulative effects result when the incremental effects of actions are added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such actions. Cumulative effects can result from individually minor, but collectively significant, actions taking place over a period of time. Past, present, and reasonably foreseeable future actions are assessed along with the effects of the alternatives to determine whether significant cumulative effects may occur. A list of existing and reasonably foreseeable projects considered in determining cumulative effects for various resources is included in Appendix C.

Climate Change

Although climate change was not brought up as an issue during Project scoping, there is a need to restore the forest ecosystem to one that is resilient to the effects of climate change.

Climate influences the processes of growth and disturbance in which the historic forest developed (Keeley and Stephenson 2000). While climate cannot be influenced by a single project or landscape scale manipulation, it can and has changed over the last 4,000 years.

Climate trends for the SNF indicate increasing temperatures with increasing precipitation over the past 100 years (Meyer and Safford 2010); however, this trend in temperature and precipitation is not consistently observed across the southern Sierra Nevada. A detailed description of climate change prepared by Meyer and Safford (2010) across the SNF is incorporated herein by reference. This past climate may not represent future climate changes. Current temperatures are rising within a short-term cycle (100 years) while temperatures are declining on a longer cycle (1,000 years) (Millar and Woolfenden 1999). It is unclear what the future will mean for climate change. Maintaining the current mosaic of forest structures may not ensure ecosystem stability (Millar and Woolfenden 1999, Schoennagel and Veblen 2004).

Maintaining functioning processes and a wide range of age and class structures may be the most realistic approach in the face of uncertainty or changing climate. The proposed action comes closest to creating a wide range of age and class structures with functioning ecological processes through implementing variable tree retention guidelines based upon ecological restoration principles (see Landscape Strategy, section 1.2.2).

No published climate change or vegetation change modeling has been carried out for the SNF. Indeed, few future-climate modeling efforts have treated areas as restricted as the state of California (Meyer and Safford 2010). The principal limiting factor in determining the effect of an individual project is the spatial scale (2.5 million acres) of the General Circulation Models that are used to simulate future climate scenarios and the lack of consensus on probable outcomes between climate models. As a result there are no current methods for measuring the effects of one project (1,500 to 5,000 acres) or landscape scale (80,000 acres) treatments on temperature or precipitation trends.

Socioeconomics

An economic costs analysis was completed for the Project to examine the economic costs associated with this Project (including administrative costs), any potential income, and the effect on employment. During Project scoping, a request was received to include a cost estimate for the actions described under the proposed action. This section summarizes the analysis of economics on all three alternatives (see Economic Costs Analysis [K. Ballard 2012] for more detail).

The harvest of timber and restoration fuel treatments generates employment opportunities. Research from Grinspoon and Phillips (2011) and Corn and Alexander (2012) indicate a relationship between employment and harvest in the Pacific Coast states during the 1980s through 2010. Each million board feet (MMBF) harvested supports six to 26 year-around direct and indirect jobs. A conservative estimate is 13.1 jobs per MMBF harvested. This equates to approximately 5.4 direct and 7.7 indirect jobs. The restoration and fuel work from non-harvest activities would support additional direct and indirect employment. There are approximately 1.4 indirect jobs for every full time field job.

The only direct costs involved with alternative 1 would be the costs to prepare the environmental analysis and documents (approximately $225,000). No potential revenue would be generated from the no action alternative.

An important effect by taking no action relates to the Sierra Forest Products sawmill, located in Terra Bella, CA., an important lumber production resource for southern California, 90 miles from the Project area. This mill is dependent on timber from the southern portion of California and should it close due to not enough timber to the mill, the economic costs to transport logs to the next nearest mill would increase. Also, the employment of wood workers, mill workers, and people in the retail sector from the harvest of trees, silvicultural treatments and fuel treatments would be foregone under the no action alternative.

Both action alternatives generate both direct costs and revenues. Revenues result from selling commercial timber to timber sale purchasers. However, each alternative would have a net cost to complete anticipated harvest. Costs result from administrative actions (environmental analysis, sales preparation, sales administration, and burn plan preparation) and post-treatment costs (small tree removal, reforestation activities [for alternative 2 only] and fuels treatments). Table 6 below summarizes these costs for each alternative.

Table 6. Implementation and administration cost estimates (in thousands) for each alternative.

	Harvest Volume (Mbf)	Timber Removal Cost	Road Mainte-nance cost	Post-Harvest Cost*	Environ-mental Assess-ment	Timber Sale Prepar-ation	Sale Admin-istration	Temp Road Cost	Total Cost
Alt 1	0	$0	$0	$0	$225	$0	$0	$0	$225
Alt 2	1655	$158	$35	$1,348	$225	$53	$32	$3	$1,854
Alt 3	165	$110	$15	$1,149	$225	$53	$32	$3	$1,587

Due to the low value of included timber, the low MBF volume per acre, and the high haul costs, both action alternatives would require funds as indicated above to remove timber.

Under the proposed action post-harvest tree removal, mechanical and hand fuels treatments costs are approximately $620,000. Prescribed fire (pile burning, underburning, jackpot burning and broadcast burning) adds approximately $481,000 dollars. Reforestation costs, which are exclusive to the proposed action, add an additional cost of $166,000. Total post-harvest implementation costs are approximately $1,267,000 for the proposed action. Total post-harvest implementation costs for alternative 3 are approximately $1,101,000. The administrative costs to implement the post-harvest activities (e.g., ground preparation of the actions associated with the alternatives [e.g., identifying trees for removal and boundary layout], and administration of the contract[s]) is approximately $81,000 for alternative 2 and $48,000 for alternative 3.

Both action alternatives provide employment opportunities directly for local woods workers, truck drivers, and mill workers. These employees pay both federal and state income taxes to support the local economy. Yield taxes are collected from purchasers upon cutting sawtimber and are paid to the state. Processed materials from mills eventually reach retail stores and provide jobs for retail workers and income and sales tax to federal and state government. Post-harvest vegetation and fuel treatments in the Project area also provide employment opportunities for the local economy. Alternative 2 would provide the greatest societal benefits. Approximately 53 direct and indirect full-time jobs would be provided in alternative 2 compared to 30 jobs for alternative 3. The expected employee income of alternative 2 is $2,120,000 and $1,200,000 for alternative 3, based on an average wage of $40,000 per full-time job.

Black-backed Woodpecker[7] and High-Severity Fire

During Project scoping, a concern was raised that the Project may potentially adversely impact the black-backed woodpecker (*Picoides arcticus*) due to the proposal to reduce the potential for moderate or high-severity fire in areas proposed for thinning and prescribed fire.

During the past decade from 2000 through 2010, the SNF has experienced a total of 53 wildfires totaling 28,419 acres, with an average fire size of 536 acres. Of the total acres burned during this period, 65 percent were categorized as moderate- and high-severity burned areas, which create the

[7] More information on the black-backed woodpecker can be found in the MIS Report for the Soaproot Restoration Project (Sanchez, J. 2012). This report is herein incorporated by reference and available in the Project planning record located at the HSRD office.

habitat types preferred by the black-backed woodpecker (USDA FS 2010). The implementation of projects designed to reduce fuel loading and fire severity does not preclude the occurrence of wildfire across the landscape, it merely seeks to lessen the extent and severity of such fires when they occur. Since treatments for the Project are limited to a maximum of 2,998 acres out of the 6,958 acres within the Project boundary (43 percent of the total area), there remains the potential for moderate to high-severity fire to occur within 57 percent of the Project area. Under current conditions, it is anticipated that approximately 27 percent would burn at high severity and 30 percent at moderate severity (Tane 2012). By 2022, modeling indicates that the amount of moderate severity fires would increase to 38 percent, while amount of high-severity fires would remain about the same (ibid.). It is reasonable to conclude that wildfires of all severity types would continue to occur across the Project area, the HSRD, and the SNF, even after implementation of the Project if it were to occur. Therefore, habitat for the black-backed woodpecker would likely continue to increase on the HSRD and across the SNF. Furthermore, current data at the range wide, California, and Sierra Nevada scales indicate that the distribution of black-backed woodpecker populations in the Sierra Nevada is stable (USDA FS 2010). Current science indicates that the total area of high-severity burned forest in the Sierra Nevada is not lower than historic reference conditions (Meyer and Safford 2010) and the size of high-severity burned patches has significantly increased (Miller et al. 2008). The entire western U. S. has experienced higher large wildfire frequency, longer wildfire durations, and longer wildfire seasons since the mid-1980's (Westerling et al. 2006). For more information on fire severity see the Wildfire and Fuels section below.

3.1. Wildfire, Fuels, and Air Quality

3.1.1. Background and Affected Environment

The focus of the wildfire, fuels, and air quality analyses[8] is to address the effectiveness of each alternative in meeting the purpose and needs for the Project related to: protection of adjacent landowners and private property from the effects of wildfire; improving effectiveness of fire suppression operations and fire fighter safety; and reducing smoke production from wildfire and prescribed fire, in turn reducing the risk of adverse effects to air quality.

Air quality was not raised as an issue during scoping, but is addressed as part of the purpose and need. A Conformity Determination is available as part of the Air Quality Specialist Report located in the Project record. The Project is considered to conform to the SIP and is not assumed to constitute a significant impact to the air quality of the SJVUAPCD. The Conformity Determination (Austin 2012) for this Project details the assumptions and calculations used to determine total Project emissions.

The wildfire and fuels analysis also addresses concerns/recommendations (not issues) brought up during scoping related to fire severity (particularly high-severity fire).

3.1.1.1. Wildland Urban Intermix

As mentioned in Section 1.1 (Introduction) the Project is located primarily in the WUI. Out of the 6,958 Project acres, 6,316 acres (90 percent) falls within the WUI land designation. The WUI is further broken down into zones. Thirty-four acres (less than one percent) is urban core, the density of structures, businesses and homes adjacent to federal land, or cabin tracts and federal facilities within the forest. The defense zone, the buffer in closest proximity (roughly within one-quarter mile) to the urban core, is 649 acres (10 percent). And 5,633 acres (89 percent) is threat zone, the buffer extending out from the

[8] The wildfire, fuels, and air quality section is a summary of the Fire and Fuels and the Air Quality Specialist Report prepared for the Soaproot Restoration Project. These reports are herein incorporated by reference and are available in the Project planning record located at the HSRD office.

defense zone approximately one and one-quarter miles. Two communities in close proximity to the Project area, Shaver Lake and Dinkey Creek, California, have been identified as "at risk" communities within the WUI as listed on pages 43389 and 43390 of the Federal Register, Volume 66 (2001).

3.1.1.2. Weather

A Pacific high pressure system begins to develop in the spring. Precipitation declines and temperatures gradually increase. This warming and drying trend leads to the beginning of fire season on the SNF by the middle of May. From June through September, the little rainfall that occurs comes from thunderstorms. Rainfall amounts are usually light and short in duration. During this period, the weather is hot and dry with temperatures in the 100's and relative humidity percentages in the teens at the 2,800-foot elevation. Wildfire ignitions are a mix of human caused and lightning. Since weather conditions vary dramatically between the lowest elevation of the Project at 2,800 feet and the highest elevation at 6,000 feet, historical weather from two remote automated weather stations (RAWS) were used in determining representative fire behavior for the Project. The Trimmer RAWS best represents the lowest elevations of the Project, while the Mountain Rest RAWS best represents the Clarence burn portions and the Providence Creek portion of the Project.

Table 7 and Table 8 display average weather conditions for the National Fire Danger Rating System weather stations at Trimmer and Mountain Rest from 1991 to 2010. The percentile weather is the average weather for 50, 90, and 97 percent of the days, for the month of August, during which only 50, 10, and 3 percent, respectively, of the days are hotter and drier.

Table 7. 50th, 90th, and 97th percentile from 1991 to 2010 for Trimmer Weather Station, SNF.

Weather Variable	50th	90th	97th
Dry Bulb (degrees Fahrenheit [°F])	94	101	104
Maximum Dry Bulb (°F)	98	104	108
Relative Humidity (%)	23	15	12
Minimum Relative Humidity (%)	17	11	9
Wind Speed – eye level, avg. gust	9	11	13
1-hour fuel moisture (%) (dead)	3.51	2.42	2.11
10-hour fuel moisture (%) (dead)	4.17	3.0	2.61
100-hour fuel moisture (%) (dead)	6.95	5.17	4.46
Live Woody Fuel Moisture (%)	60	60	60

Table 8. 50th, 90th, and 97th percentile weather 1991 to 2010 for Mountain Rest Weather Station, SNF.

Weather Variable	50th	90th	97th
Dry Bulb (°F)	84	91	94
Maximum Dry Bulb (°F)	87	94	97
Relative Humidity (%)	29	18	14
Minimum Relative Humidity (%)	21	13	10
Wind Speed – eye level, avg. gust	8	9	10
1-hour fuel moisture (%) (dead)	4.42	2.95	2.38
10-hour fuel moisture (%) (dead)	5.0	3.45	2.89
100-hour fuel moisture (%) (dead)	6.81	5.02	4.45
Live Woody Fuel Moisture (%)	70	70	70

Dead fuel moistures can indicate a wildfire's ability to spread. Wildfires usually spread in a continuous flaming front. When the 10-hour fuel moisture (measured in dead fuels that are ¼ to 1 ¼ inches in diameter) drops below a rating of six, wind can throw embers ahead of the flaming front and start multiple small fires called spot fires. Generally the higher the wind speed, the further the spot fires occur from the main fire. As these spot fires burn together they cause the speed and intensity of the fire to increase dramatically. Multiple spot fires are an indication of extreme fire behavior. It is not uncommon for these conditions to exist during the height of the fire season every year.

The high pressure of summer begins to break down by mid-September. Although dead fuel moisture levels can remain quite low, the heat of summer is gone. Fire season is usually over by the end of October.

Prescribed fire operations, in the form of slash pile burning, can usually start in late October and may continue until precipitation makes the fuels too wet to ignite, usually sometime in November, but as late as January in extremely dry years. Usually underburning does not start until some light precipitation occurs.

Prescribed fire operations in the fall months face three obstacles:

- The demand for fire crews to remain in a state of readiness for the southern California Santa Ana fire season precludes long-term commitment of fire crews to prescribed fires.
- Without adequate precipitation, fuel moisture remains too low to meet prescribed fire objectives or once the rainfall starts, it comes too frequently to allow fuels to dry sufficiently enough to carry fire.
- Fall weather patterns in the San Joaquin Valley Air Basin create poor air movement, which traps smoke and other pollutants in the populated valley thus causing unhealthy conditions. Adequate air movement that would disburse smoke from prescribed fires usually only occurs during weather frontal passages. These frontal passages sometimes provide small windows of opportunity to conduct prescribed fire operations.

Due to these factors, fall prescribed burns tend to be (with some exceptions) of short duration and easily managed.

The ability to conduct prescribed fires in the winter and spring months is precipitation-dependent and varies from year to year. Favorable conditions for large scale underburning usually develop beginning in April or May and depending on weather are on again/off again through the middle of June.

3.1.1.3. Actual and Modeled Fire Behavior

Fire behavior is the manner in which a fire reacts to the influences of fuel, weather, and topography. Fire behavior models (BehavePlus 2008) predict that in untreated ponderosa pine and mixed conifer stands, wildfire behavior can be characterized by high-intensity surface fires. Torching of trees (passive crown fire) is likely, with some active crowning possible depending on wind conditions. Fires of this type would result in mixed to lethal mortality in both moderate and severe fire conditions. Table 9 below shows the fire behavior outputs of different fuel models representing existing conditions and the desired condition for the Project area.

Table 9. Comparison of fire behavior outputs by fuel model using 90th percentile (Trimmer RAWS) and two wind speeds.

Fuel Model	Flame Length (ft)	Rate of Spread in chains per hour (ft/min)	Scorch Height (ft)	Heat per Unit area (btu/ft2)	Fire Type (modeled in BehavePlus)
FM8 (desired condition) – 11 mile per hour (mph) wind	1.3	2.4	4	242	Passive crown fire

Fuel Model	Flame Length (ft)	Rate of Spread in chains per hour (ft/min)	Scorch Height (ft)	Heat per Unit area (btu/ft2)	Fire Type (modeled in BehavePlus)
FM5 (Mixed Chaparral) -11 mph	7.8	33.1	108	808	Active Crown Fire
FM10 (Timber over-story with Brush understory) -11 mph	6.6	11.7	85	1617	Active Crown Fire
SB3 (slash/blowdown) – 5 mph wind	11.4	45.3	243	1772	Passive Crown fire
SB3 (slash/blowdown)– 10 mph wind	25.5	108.7	432	1772	Passive crown fire

The fuel models in Table 9 above represent the following conditions:

- FM8 represents surface fuel loadings and fire behavior in the desired condition.
- FM5 is a brush model that best represents the mixed chaparral types in the Project area.
- FM10 is a timber model that has a brush understory component. This model best represents most of the ponderosa pine and Sierra mixed conifer stands within the Project that do not have bug activity.
- SB3 is a slash blowdown model. This model represents those pockets of bug killed trees within the Project that have become or will become surface fuels. Surface fuel loading in these areas is greater than 100 tons per acre and the corresponding fire behavior as displayed by the chart shows the increased intensity that these conditions present.

Figure 7 below is a comparative fire hauling chart that shows fire behavior for various fuel models using 90th percentile weather variables (C. Ballard 2011). Figure 7 also displays the capability of firefighting resources to effectively attack a wildfire burning at 90th percentile weather conditions in the various fuel models. Two different wind speeds are shown: five mph for general 50th percentile wind conditions and 10 to 11 mph which is the average 90th percentile wind from both weather stations.

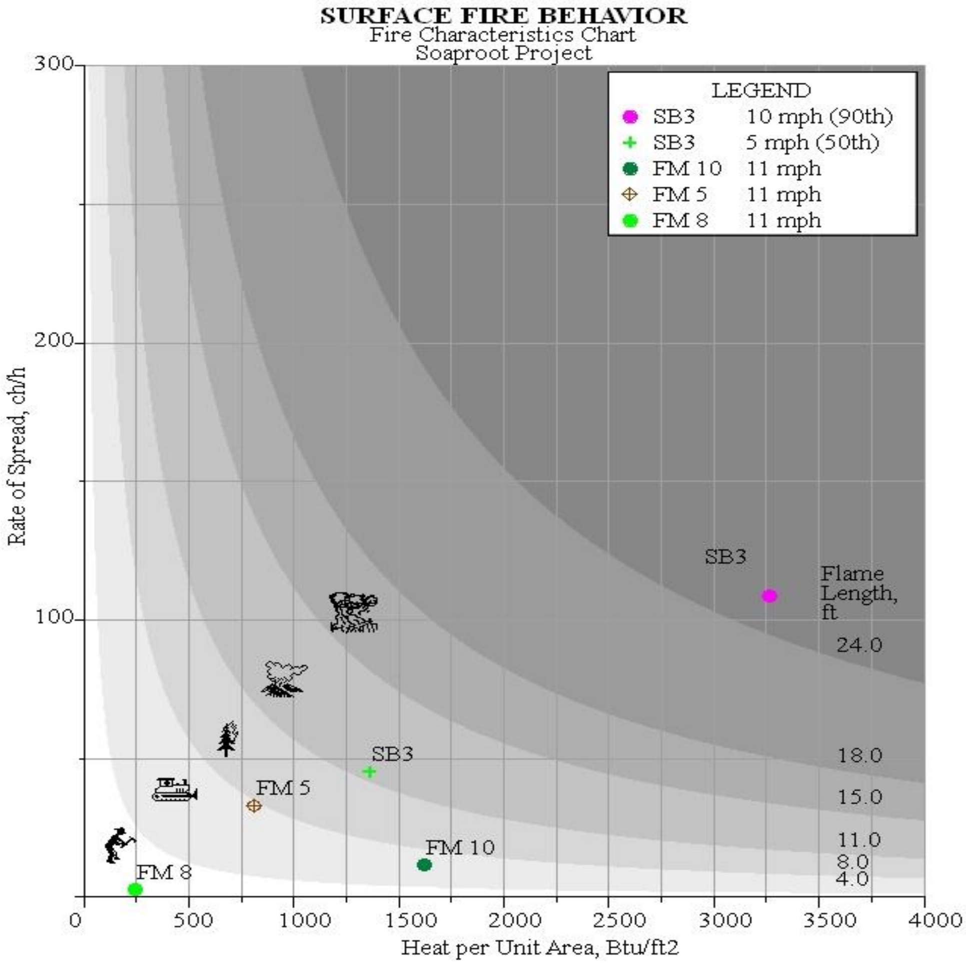

Figure 7. Fire characteristics chart shows a comparison of fire behavior for different fuel models using 90th percentile weather (Andrews et al. 2011).

The symbols depicted in Figure 7 above display the following:

- FM8: fire can generally be attacked at the head or flanks by firefighters using handtools. Handlines should be successfully held.
- FM 5 and FM10: Fires are too intense for direct attack on the head of the fire by firefighters using handtools. Handline cannot be relied on to hold fire. Equipment such as dozers, fire engines, and retardant aircraft can be effective.
- SB3 (five mph winds): Fires may present serious control problems such as torching, crowning, and spotting. Control efforts at the head would probably be ineffective.
- SB3 (10 mph winds): Crowning, spotting, and major fire runs are probable. Control efforts at the head of fire are ineffective.

The recorded fire history of the Project area dating back to 1916 shows a total of 30 fires. Twenty-six fires were less than 10 acres in size and were a mix of human caused and lightning. Four large fires have occurred in the Project area or moved into the Project. The largest was the 1932 Davis Mountain Fire (7,341 acres). Others included the 1947 Bretz Fire (3,020 acres) and two unnamed fires in 1918 (3,003 acres) and in 1931 (714 acres). All four of the large fires were human caused. Much of the Bretz Fire area burned at a high-intensity, stand-replacing level.

The Bretz Fire started in the Big Creek drainage in late August of 1947 and in three days burned northeast to the Dinkey Shaver ridgeline at Markwood Meadow. Historical records (available at HSRD office) briefly describe the crowning fire and winds that carried embers from the burning Bretz lumber mill upslope with the prevailing daily up-canyon afternoon winds. Though weather variables (temperature, relative humidity and wind) and fire behavior specifics were not documented, the narratives discuss how mill workers and firefighters were surprised by the occurrence of a running crown fire and how far embers were thrown. Also discussed was the fact that the Grand Bluffs (recognizable large granite rock outcrop northeast of the mill) did not stop the advancement of the fire.

Fire history data and frequency (all fires by size class) for the entire HSRD (1965 to 2005) was entered into ProbAcre, a model used for computing aggregate burned acreage probabilities for wildfire risk analysis. The analysis is reflected in the following figures. Figure 8 shows the probability of the risk of loss in acres. Figure 9 shows the probability of acres lost over time.

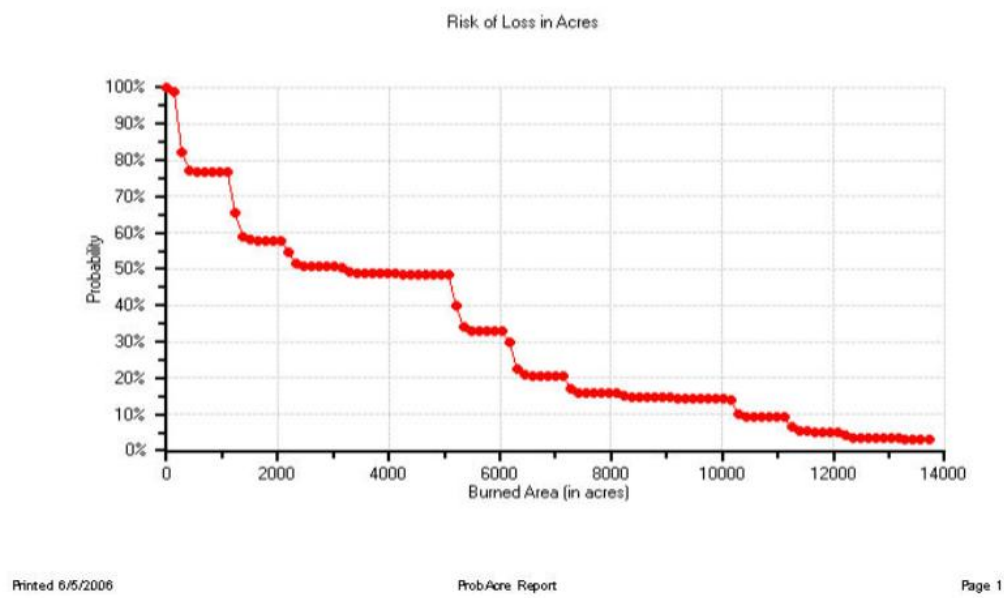

Figure 8. ProbAcre Analysis - risk of loss in acres.

There is a 75 percent probability that all fires occurring on the HSRD would total 1,000 acres every year. There is a 50 percent probability that the total acreage burned over the HSRD would be roughly 2,200 to 5,000 acres every year.

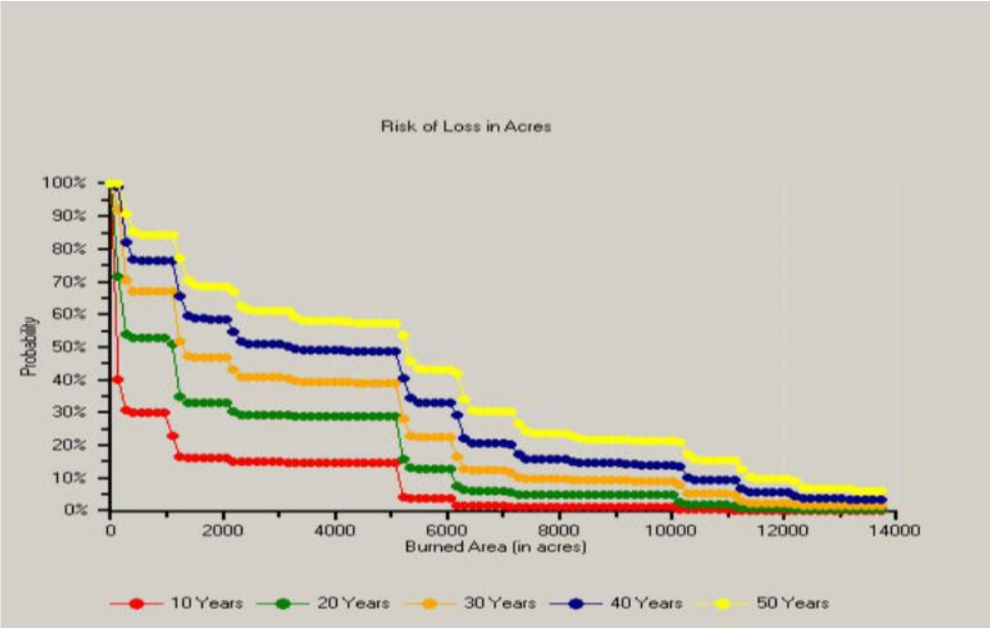

Figure 9. ProbAcre Analysis - probability of risk of loss in acres over time.

Figure 9 shows that there is a 15 percent probability that a 2,200 to 5,000 acre fire would occur on the HSRD within the next 10 years. There is a three percent probability that a 13,712 acre fire would occur within the next 40 years. The combined charts (Figures 8 and 9) indicate that there is a 52 percent probability that a 2,742 acre fire would occur in the next 40 years (Ballard and Bahro 2006).

3.1.1.4. Fire Severity

Striking changes in structural and functional components of Sierra Nevada ecosystems have occurred since 1860, largely due to dramatic modifications in the pre-Euro-American settlement fire regime (Brown et al. 2004, Fettig 2012). Today unnatural fuel accumulations occur in many fire-dependent forest ecosystems along with associated increases in forest stand densities. With these shifts have come changes in fire regime characteristics including large stand-destroying fires (Caprio and Graber 2000, McKenzie et al. 2004, Miller et al. 2009b). Altered fire frequencies caused by a century of fire suppression in ponderosa pine forests characterized by a frequent low-intensity fire regime, coupled with prolonged drought and epidemic levels of insects and diseases, have coincided to produce extensive forest mortality and the eventual increase in fuels and has contributed to greater stand densities and an increase of crown fire potential (Mutch and Cook 1996, Westerling et al. 2006, Scholl and Taylor 2010, Collins and Stephens 2010, Safford et al. 2012). Bulaon and Keihl, in their Forest Health Protection Report to Scott Armentrout (2011a), found that other possible contributors to the increasing forest health activity include successive drought years, overstocking, root disease and recent winter storm damage. In the report they document the increase in bark beetle activity since 2006. Estimated total acres of mortality from 2005 to 2010 in the Project boundary equals 953 acres. Bulaon and Keihl also state that the current levels of bark beetle activity will create an immense future fuel load. Figure 10 below shows the increasing level of beetle activity within the Project and where fuel loading is increasing due to fall rate of infected trees.

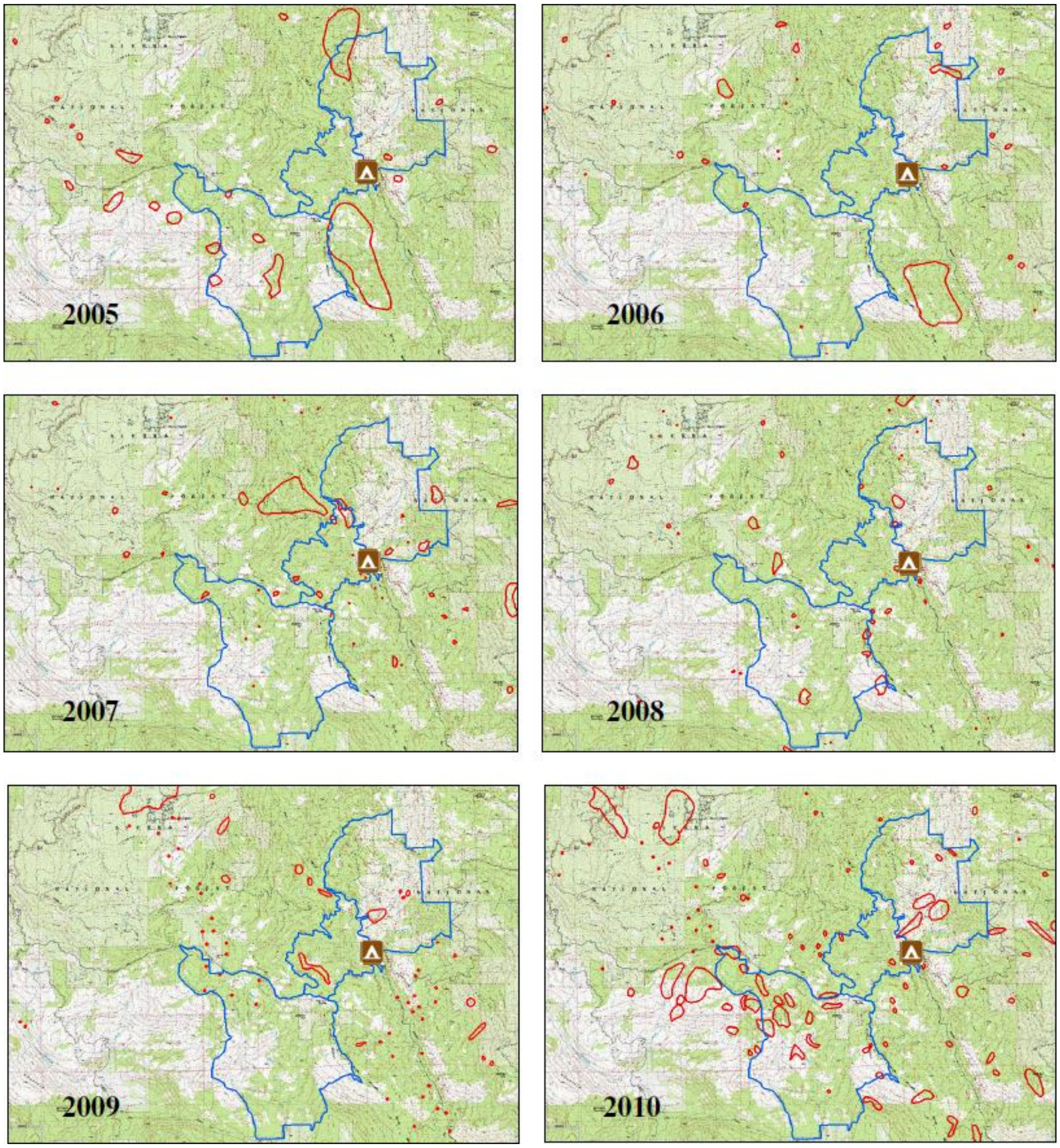

Figure 10. Aerial surveys from 2005 to 2010 of the Big Creek Watershed, HSRD.

In Figure 10 above, the blue boundary is the Project boundary. The red polygons are each individual year's aerially mapped bug killed trees. The years are not cumulative; each map shows just that year's new mortality.

The photos in Figure 11 below were taken from within the Project area in the spring of 2012 and are from the 2007 bug infestation adjacent to and within the Clarence burn area. The photos illustrate the fuel loading accumulation from bug killed trees; it is this fuel loading that is best represented by fuel model SB3 discussed in Fire Behavior above. The western bark beetle strategy (USDA 2011b) describes the fire hazard created by beetle outbreaks:

> "In addition to the danger of dead trees falling on people and infrastructure, beetle outbreaks create a fire hazard, which is especially relevant in the WUI and municipal watersheds. Due to the dead needles retained in the tree's crown, fire hazard increases one to two years after pine trees die. These needles (red-needle phase) stock the canopy with dry, fine fuels that can ignite quickly during weather conditions conducive to fire. Canopy fires are notably difficult to suppress. The overall risk posed by fire temporarily decreases after the dead needles have fallen while the trees remain standing (0 to 10 years after the trees

are attacked). From 10 - 20 years onward, the fire hazard increases again. As dead branches and trees fall, a heavy fuel bed is created, which poses an increased risk of a surface fire. The outbreak increases the number of acres of municipal watersheds and WUI in need of treatment to protect communities and infrastructure from fire. Additionally, due to the lack of safe egress and intense burning conditions created by standing beetle killed trees or down heavy slash, fighting these types of fires is extremely dangerous to fire fighters."

Figure 11. Heavy fuel loading (example of fuel model SB3) created by bug killed trees on FS 10S18 road within the Project area.

Fuel loading within the Project boundary has also increased due to winter storm damage in 2009/2010 and 2010/2011. Severe winter storms (strong winds and heavy snow loads) caused many green trees to snap mid-bole, and drop green limbs during the winter of 2009/2010. Consequently, this green debris provided optimal brood sites for additional pine beetle infestations as shown in Figure 12 below with a large increase in infestations in 2011. It is noted in the western bark beetle strategy (USDA 2011b) that that the western U.S. is experiencing the largest bark beetle outbreak in recorded history.

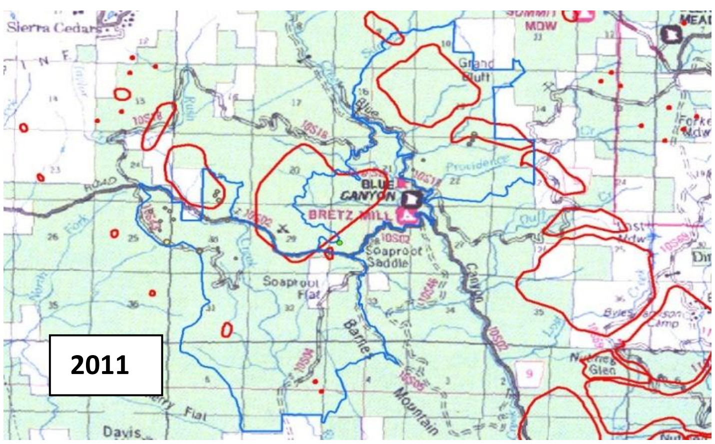

Figure 12. Aerial survey of increasing bark beetle activity in the Big Creek drainage and Project area.

The heaviest snow damage was in pockets of small trees. One site within the Project boundary documented over 20 trees (greater than five inches DBH) that were sheared off by high winds in one stand alone (USDA 2011a). Figure 13 below shows other sites of extensive storm damage. These sites increase the fire hazard and severity of wildfire in the Project.

Figure 13. Three photos of storm related damage increasing fuel loading and providing bark beetle host sites within the Project area.

The Project area is a fire prone ecosystem dominated by ponderosa pine. Historically, the ponderosa pine fire regime type was considered to be a low-severity fire regime (Noss 2006, Stephens et al. 2007, Thode et al. 2011). Thode et al. state that “grazing, fire suppression and other management practices have caused this lower elevation frequent fire regime to burn more severely than it did historically” (2011). Recent research suggests that increases in temperature related to global warming are also contributing to increasing fire severity (Running 2006, Safford et al. 2012,Westerling et al. 2006).

Fire Return Interval (FRI) is used to approximate how often in years ‘on average’ a given Pre-settlement Fire Regime (PFR) likely burned in the three to four centuries prior to significant Euro-American settlement (Safford et al. 2011, Thode et al. 2011). The historical FRI departure (FRID) is commonly used to denote current departure from the pre-Euro-American settlement FRIs (Safford et al. 2011). The regional ecology group mapped PFRs for the state of California and it is from this data that the Project PFRs are defined. A total of 5,481 acres or 70 percent of the Project is classified as a ponderosa pine PFR (Safford et al. 2011). Safford et al. (2011) defined the median reference FRI for yellow pine[9] to be 7 years. Stephens et al. (2007) found the median FRI to be five years for ponderosa pine. This indicates that prior to Euro-American settlement fire would have burned through the Project on average every five to seven years. This frequency kept the fire intensity and severity low.

[9] Yellow pine is a term used for several closely related species of pine with yellow tinted wood, including ponderosa pine and Jeffrey pine.

While historical conditions may not be entirely relevant given the uncertainties associated with climate change, "the historical ecology… represents our clearest window into ecological patterns and processes that occur at temporal scales beyond the scope of human observation" (Safford et al. 2012). Others, including Hanson, contend that large severe fires are not outside that which occurred naturally. Hanson also contends that natural fire rotation (or fire cycle) should be the frequency metric used in determining the true time it takes for fire to burn an area equal to the area of the landscape. McKenzie and Kennedy (2011) state that to calculate fire cycle depends on accurate estimates of the sizes of every fire in the sample area, and that this is a difficult task in historical low-intensity fire regimes. Reed (2006) recommends that the notion of fire cycle in its current form be abandoned.

The occurrences of such severe large fires are well outside the natural range of variability and thus considered detrimental to Sierra Nevada ecosystems (Weatherspoon and Skinner 1995, McKenzie et al. 2004, Stephens et al. 2007). According to Stephens (2005), annual wildfire acres in the western U.S. have increased in the last 60 years, where California has experienced the highest amount of acres burned (Miller et al. 2009b). Miller et al. (2009b) showed that during 1984 to 2007 fire severity greatly increased with the pattern concentrated in middle elevation conifer forests; the average during the beginning of this period was 17 percent high severity, while the average for the last 10 year period was 30 percent. Miller et al. (2012) found that the percentage of high-severity fire in the Sierra Nevada larger than 4,942 acres occurring from 2000 to 2008 was more than twice as high for the same period in other parts of California. Stephens et al. (2007) also contends that while wildfire severity is increasing, the numbers of acres burned overall is not out of range as to what probably burned in California during the prehistoric period. Data demonstrates that the magnitude of that departure is increasing with time. Recent research on historic fire regimes prior to Euro-American settlement, support the view of a predominance of low-severity fire effects on stand development (Scholl and Taylor 2010, Collins and Stephens 2010).

3.1.1.5. Fire Type

The fire regime is now shifting towards one of infrequent higher severity fires due to the increase in flammable vegetation and increasing fuel loads which has increased the potential for crown fire (Westerling et al. 2006). Crown fires are considered the main threat to ecological and human values and they are one of the biggest challenges of fire management (Busenberg 2004, Agee and Skinner 2005, Miller et al. 2009a, Spies et al. 2009, Miller et al. 2012). Fire managers recognize three different types of crown fires. Passive crown fires kill individual trees or small groups of trees and are often referred to as "torching". Active crown fires are continuous burning the entire tree canopy, but are dependent on heat from surface fires for continued spread. Independent crown fires also burn the entire tree canopy but they are independent of surface fires. Independent crown fires, which are rare, only occur in the most extreme situations and are poorly understood. Passive and active crown fires are the main concern for the Project area because of the current fuel conditions (dense, unnatural fuel loads, ladder fuels and regeneration).

The potential for passive and active crown fire is related to surface fuel loading, height to live crown (the presence of fuel ladders which draw fire up into tree crowns), and canopy density. Fire type in chaparral stands (montane chaparral and brush) is considered a surface fire as there are little to no trees present in the overstory to carry passive or active crown fire. Surface fires occur as flames burning across the forest floor. Passive crown fire is common in the Project area especially under moderate fire weather conditions and light surface fuels. Where fuels are heavier, the potential for crown fire exists, especially in untreated stands with moderate to high canopy bulk density.

Within the Project area, there is little ground that has seen enough fuel reduction treatments to effectively reduce surface fuels to a light fuel load that would prevent passive and active crown fire. The 2011 Barnes Fire occurred under moderate fire weather conditions on September 14, 2011. This lightning-ignited wildfire started in the Barnes North underburn area of the Big Creek drainage just east of the Project boundary. This area has been underburned three times in the last 18 years and the surface fuel loading averaged less than 15 tons per acre. The fire type was passive crown fire with surface flame lengths at four feet; torching (passive crown fire) was occurring in groups of pines under stiff winds. If this fire had ignited in an untreated stand within the Project under high fuel loading (Refer to **Error! Reference source not found.**Figure 11, as discussed in Fire Severity above), given the winds at the time (gusts up to 20 mph), this fire would have become an active crown fire.

3.1.1.6. Indicators

The effects of the alternatives were evaluated using the indicators below. The indicators were selected as being the most meaningful and relevant to quantifying the effects on the landscape for protecting the values at risk and for restoring fire as an important process in the ecosystem.

Indicator 1: Fire Behavior Flame Length

Flame lengths can be used as an observable measure of fireline intensity[10] or fire behavior and is typically modeled at the flaming front of the fire or the rate of forward spread. Although fires can be dangerous at any intensity, small flames are easier to extinguish than tall flames. The implications of observed or expected fire behavior are important components of suppression strategies and tactics, particularly in terms of the difficulty of control and effectiveness of various suppression resources. Fires that have flame lengths of less than four feet require fewer suppression resources are the easiest to control, and pose the least amount of danger to wildland fire fighters (see Table 9 and Figure 7).

Indicator 2: Fire Severity

Predicted acres can be used to measure high, moderate and low fire severity. Fire severity is the magnitude of the effects that fire has on the environment. It includes both fire effects that occur while the fire is burning over an area as well as those effects that occur in the post-fire environment. The potential for tree mortality is based on percent basal area that would be killed in a severe wildfire based on 90th percentile weather variables (Reinhart and Crookston 2003). Low-severity fire is categorized as less than 25 percent basal area mortality, moderate is 25 to 75 percent mortality and high is characterized as greater than 75 percent basal area mortality.

Indicator 3: Predicted Wildfire Type

The degree of crowning (surface, conditional surface, passive and active) is used as an indicator of the fire hazard of fuel and stand conditions. Forest managers have long contended that stand structural changes can be linked to more extreme wildfire behavior (Pollet and Omi 2002, Scholl and Taylor 2010, Stephens et al. 2009). It has been documented that sites with harvest treatments that included complete slash removal had lower fire severity (Weatherspoon and Skinner 1995). Results from research (Omi and Martinson 2002, Pollet and Omi 2002) indicate fuel treatments that remove small diameter trees may be beneficial for reducing crown fire hazard. Furthermore, fuel treatments such as prescribed burning and mechanical tree removal, mitigate fire severity; this is primarily true in ponderosa and mixed conifer forest. The best results occur when the two treatment methods are applied together (Agee and Skinner 2005, Collins and Stephens 2010, Harrod et al. 2009, North et al. 2007, North et al. 2009).

Both active and passive crown fires create spot fires; sometimes up to ¼ to ½ mile ahead of the main fire front. Spot fires greatly increase the resistance to fire control and cause dangerous situations for

[10] Fireline intensity is expressed as the amount of heat released in British Thermal Units (BTUs).

firefighters and the public. When the severe weather and stand density conditions for an active crown fire exist but do not develop, it is referred to as a conditional surface fire. Under these conditions, the fire may or may not cause torching or an active crown fire. Surface fires also create spot fires but are not generally as problematic as the crown fires.

3.1.2. Environmental Consequences

3.1.2.1. Alternative 1 (no action)

Direct Effects

There are no treatments under the no action alternative and therefore, there are no direct effects related to wildfire and fuels.

Indirect Effects

Flame Length

The no action alternative would increase the extreme risk and effects of severe wildfire to the resources and WUI communities in and adjacent to the Project area. Under this alternative, there would be an increase in the susceptibility of stands to disturbances such as fire, insect, and disease outbreaks over time as fuel loadings continue to increase due to conifer mortality and increasing stand densities. Fire control tactics could be far more costly and less effective.

The heavy fuel loadings left in place by choosing the no action alternative would leave dense stands of trees, both live and dead across the Project area. Snags tend to have low moisture content during the fire season and more readily ignite during wildfires than live trees. The ability to easily ignite allows winds to carry burning embers long distances and create spot fires beyond the front of the main fire; this increases the fire's speed (rate-of-spread), in turn increasing risk to private land and structures within and adjacent to the Project.

There is a net increase in general fire hazard in the Project (based upon flame lengths) over the 30 year modeling period under alternative 1 (see Figure 14). During this 30 year time period, more ground fuels would have accumulated due to the natural falling of snags to the forest floor providing an environment for a hot soil-altering fire environment.

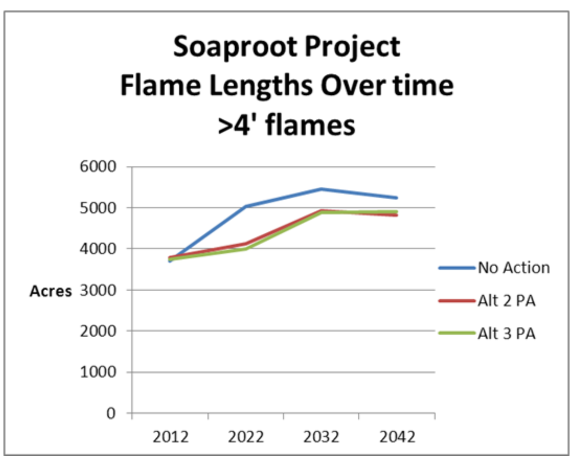

Figure 14. Potential flame lengths over time for each alternative.

Over time this increase in fuel loading increases the risk to firefighter and public safety as well as firefighter access and egress within the Project.

While the SNF does not burn as many acres annually as its neighboring forests to the north and south, wildfires are frequent and large enough to have detrimental effects on the human population and forest environment.

High-intensity wildfire as represented by flame length greater than four feet would continue throughout the Project area. Modeling currently shows that over 72 percent (5,026 acres) of the Project have flame lengths greater than four feet (see Figure 15) and do not meet the desired condition or S&Gs for fire behavior within the WUI. This percentage of high-intensity wildfire does not reflect the fire behavior that would exist from increased fuel loading in bug infested pockets that have occurred over the last two years; thus the potential acres for flame lengths to be greater than four feet are under represented by the modeling. Nor does this alternative meet the purpose and need for fire hazard reduction or firefighter and public safety.

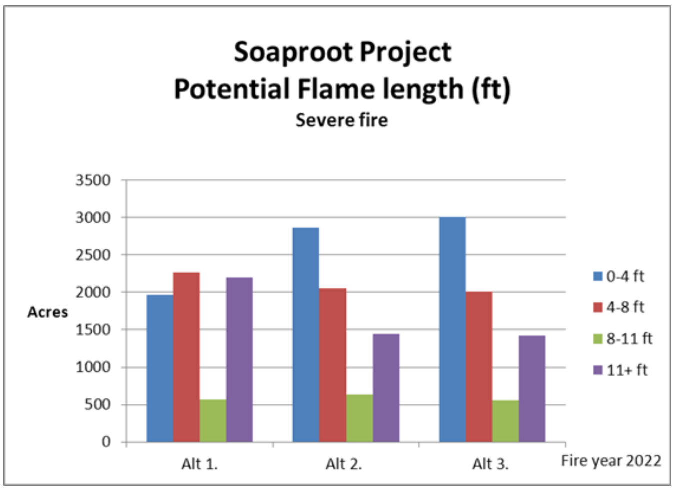

Figure 15. Potential flame lengths in acres for each alternative.

Fire behavior modeling as discussed in the Affected Environment (Figure 7) shows the increased hazards created by the increasing fuel loads. Fire behavior flame lengths greater than eight feet are not directly suppressible by local firefighting resources and would require air support and indirect attack. Fire intensity in this range is very uncharacteristic of historic fire (Agee and Skinner 2005). The indirect effects of the no action alternative are the probability of stand-replacing, intense fire where stand density has increased and dead fuels have accumulated in excess of historical levels (Agee and Skinner 2005, Brown et al, 2004). Cruz and Alexander (2010) state that there is a marked bias in under predicting crown fire potential in models using the standard Rothermel's 1991 fire spread equation (included in the Forest Vegetation Simulator [FVS] with the Fire/Fuels Extension [FFE] described in more detail in Fuels Report [C. Ballard 2012]) versus wildfire observations; this under prediction of high-intensity fire coupled with increasing rates of surface fuel loading increases the amount of acres in the Project that are susceptible to wildfire behavior rates that are not suppressible by firefighting forces under 90th percentile conditions.

An opportunity to alter undesirable stand structures and species compositions would be lost should the unwanted conditions and disturbances continue. This would lead to the perpetuation of heavy fuel loadings that contribute to high wildfire intensities to exist in what has essentially become an environment occupied by both human beings and native wildlife species.

Fire Severity

Recent research by Safford et al. (2012) shows that wildfire severity in untreated stands can be significant in dry yellow pine and mixed conifer forests that are highly encroached and long unburned.

These types of forests have developed a more homogenous structure due to previous harvesting of larger trees and fire exclusion, which has allowed dense stocks of younger trees to fill in (Safford et al. 2012). Forest managers have argued that changes in stand structure and extreme wildfire behavior can be linked (Collin et al. 2011, Miller et al 2009b, Pollet and Omi 2002, Scholl and Taylor 2010).

Error! Reference source not found.Error! Reference source not found. Figure 16 displays the results of a simulated fire that burns unheeded through the Project. It compares the post-treatment severity of a wildfire under 90th percentile weather (severe fire) to the no action alternative. Under alternative 1, moderate- and high-severity fire (red and green) covers approximately 4,355 acres, or 62 percent of the total Project area, and low-severity fire covers 2,637 acres or 37 percent of the Project area.

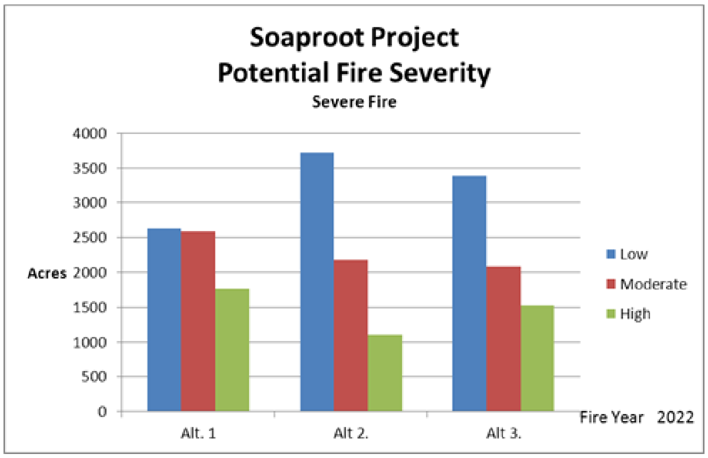

Figure 16. Potential fire severity in acres for each alternative.

Under alternative 1, the current stands structures and heavy fuel loading would continue to increase, perpetuating and increasing the amount of acres that would be severely affected by a high-intensity (severe) wildfire. Infilling of fire-intolerant trees and brush would change those stands that are predicted to be at moderate severity to levels that would create high-severity fire if left untreated.

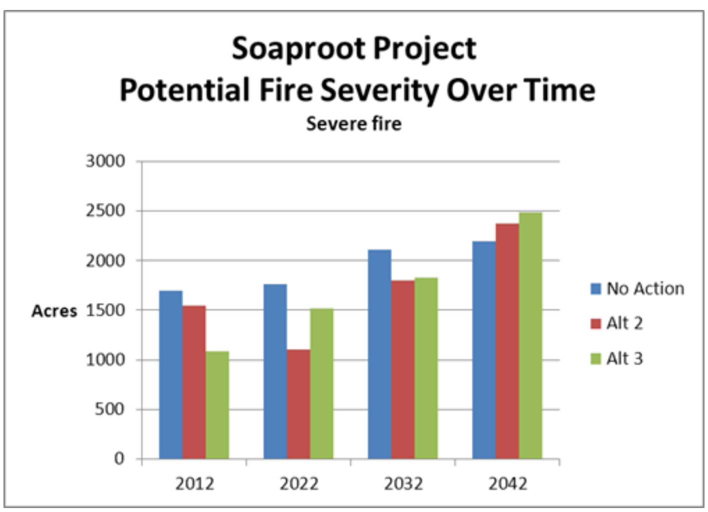

Figure 17. Potential high-severity fire by alternative over time.

Figure 17 above shows that over the 30 year time frame all alternatives increase in acres of high-severity fire but alternative 1 has a more dramatic increase in the first 20 years as compared to the action alternatives. Safford et al. (2012) found that forests have transitioned away from fuels being the limiting factor to fire severity to now having climate being the limiting factor to the severity of wildfires. As fuel loading continues to increase and infilling occurs across the Project area, the number of acres that burn at a high-severity level increases from 25 percent of the landscape in 2022 to over 30 percent by 2032. These trends are supported by recent research that has found fire severity increasing in recent decades (Miller et al. 2012, Thode et al. 2011).

Recent articles suggest high-intensity, or stand-transforming fire creates ecologically-vital "snag forest habitat", which is rich with large snags, large downed logs, dense pockets of natural conifer regeneration, patches of native shrub habitat or montane chaparral, and large live trees (Hanson 2010, Odion and Hanson 2006). This same literature indicates that high-intensity (high-severity fire) is lacking and rather than a threat to Sierra Nevada forests, is a benefit. However, published peer reviewed articles indicate that there is no evidence that high-severity burned areas are deficient in the entire Sierra Nevada or the southern Sierra Nevada region. In addition, recent science articles indicate that research used by Hanson (2010) to support the case for more high-severity fire are erroneous and deficient and do not support the conclusions for more high-severity fire (Collins et al 2011a, Miller et al. 2012, Running 2006, Spies et al. 2009, Westerling 2006). Furthermore, articles used in Hanson (2010) show a bias against active management by ignoring recent science and risk factors in dry forests that do not support his opinions. Current science indicates that the total area of high-severity burned forest in the Sierra Nevada is not lower than historic reference conditions (Collin et al. 2011, Meyer and Safford 2010, Miller et al. 2012) and the size of high-severity burned patches has significantly increased (Caprio and Graber 2000, McKenzie et al 2004, Miller et al 2009b).

Fire Type

Table 10 shows the amount of potential passive and active crown fire and surface fire within the Project under alternative 1 as compared to alternatives 2 and 3. The FVS-FFE models under predict the amount of passive and active crown fire potential on the landscape under current conditions since two successive years of extensive tree mortality have generated more slash and standing dead trees (Hicke et al. 2012) from the time the data was first collected and modeled. Collin et al. (2001b), Cruz and Alexander (2010), Johnson et al. (2011), and Keane et al. (2010) also state that use of existing models that use commonly acknowledged fire spread models have a marked under prediction when used to assess potential crown fire behavior. Given the potential for under prediction, the results of modeling for the Project would then under predict the total potential for crown fire within the Project as compared to the results below. "The reality of fire behavior predictions is that overestimates can be easily readjusted without serious consequence; underestimations of behavior can be disastrous to both operations of fire controllers and the person making the predictions" (Cruz and Alexander 2010).

Table 10. Acres of fire type for potential wildfire for all alternatives.

	Alt 1.	Alt. 2	Alt.3
Surface	5181	5924	5853
Passive	1325	908	940
Cond Surface	280	101	112
Active	207	64	91

During severe wildfires (flame lengths greater than four feet), the safety of firefighters and the public into or away from the fire can be jeopardized by unsafe evacuation routes. As the public is being evacuated, firefighters would be using these same roads for access to the fire area. In the event of an evacuation on these narrow, single lane dirt roads, hazards to the public along the roads include snags and heavy fuel loading in the form of dense stands of trees, brush, and downed logs that would cause high-intensity fire and put lives at risk.

An indirect effect of the alternative 1 is that hazardous fuels would not be removed, leaving conditions that create high-intensity fire in the form of passive and active crown fire. The conditions created by this type of fire are unsafe for firefighter and public movement to and from the fire.

The Project area like much of the south-western forests are currently at high risk of severe crown fire (Fiedler et al. 2002, and Schmidt et al. 2002 in Strom and Fule' 2007). The opportunity to conduct fuels reductions treatments to reduce the unintended long-term effects of past fire suppression, overgrazing and conventional timber harvesting would be foregone. Therefore the indirect effects of alternative 1 would be the increased fragmentation of the ponderosa pine forest, increased soil damage and ecological and social effects of increased fire severity in such a manner that are not yet entirely known. Climate change is forecasted to accelerate these effects and the shift of vegetational states caused by fire (Strom and Fule', 2007). The opportunity to conduct vegetation and burn treatments that would reduce the hazards to firefighters and the public would be foregone.

Cumulative Effects

The high fire danger that exists in the Project areas does not stop at the Project area boundary. As described in the Affected Environment (section 3.1.1), the hazard is considerable and spreads throughout the national forests of the Sierra Nevada Mountains. Because the problem is so widespread, it is necessary to concentrate fuels treatments on high priority areas where important forest ecosystems and the human environment coexist. Due to the large scale of the fire hazard and the potential spread of wildfire from outside the Project area, the landscape scale is used as the geographic boundary for cumulative effects analysis. The ongoing and foreseeable vegetation management projects within the Project area are of limited scope in reducing hazardous fuel conditions (see Appendix C).

Flame Length, Fire Severity and Fire Type

Plantation work that would occur under the Snowy Patterson Project would reduce the fire hazard but only where the treatments would be scheduled to occur and have no direct benefit to the landscape. Cumulatively, this plantation work along with other green commercial thinning timber sales that have occurred in the last decade and are directly adjacent to the Project provide effective hazard reduction within those treatments. Together these projects thinned overly dense stands and removed hazardous fuel loadings to effectively reduce the fire behavior flame lengths and severity of a wildfire in those treatment units. Those treatments do nothing to reduce the fire behavior and intensity of a wildfire within the Project boundary as none of the projects are directly adjacent to or within the Project area with the exception of the 10S18 FRP Timber Sale. This project is within the boundary of the Clarence burn. It was created as a defensible fuel profile zone for the protection of the community of Shaver Lake and burning the Clarence underburn portion of this Project would maintain the effectiveness of those treatments.

Cumulatively, the HSRD underburn program which overlaps a portion of this Project (the Clarence, Rush and Little Rush Underburn Units) as well as those burns that are directly adjacent to this Project (Barnes North and South underburns) will have localized benefits in reducing the dense and flammable forest conditions and would reduce this wildfire hazard within the Project area. The effectiveness of adjacent treatments on fire behavior inside the Project is assumed to have a 2:1 ratio (USDA FS 2001): for every 2 acres treated, 1 acre of untreated vegetation would benefit from a reduction in fire behavior. The flame length is not only reduced on the treated acre but on the adjacent acre as well. The reduced flame length means lower mortality in the untreated adjacent acre.

3.1.2.2. Alternative 2 (proposed action)

Direct Effects

The direct effect of the proposed action is the reduction of high-severity and high-intensity fires within the treated stands. The combination of treatment strategies (mechanical and prescribed fire) that include surface, ladder and crown fuel treatments reduce surface flame lengths, moderate fire severity across the landscape, and reduce the potential for active and passive crown fire within the Project. Noss et al. (2006) found that where low-severity fires were historically most common, the restoration of dry ponderosa pine and dry mixed conifer forests is ecologically appropriate. Active (mechanical thinning of small stems and prescribed fire) or passive (wildland fire use, livestock removal) management can restore stand densities to the levels that existed prior to fire suppression. Reducing height to live crown and surface and ladder fuels is the most effective treatment for reducing the effects of wildfire. Removing trees that are less than 12 inches DBH (North et al. [2009] uses 16 inches as a general upper diameter limit for ladder fuels) increases the resiliency of the forest to wildfire (Martinson and Omi 2003, Omi and Martinson 2002, North et al. 2009). Collins et al. (2011b) found that conservative ladder fuels removals (less than or equal to 12 inches DBH) may not effectively reduce ladder fuels or the desired effect only lasts seven to 10 years.

Removal of trees can reduce the potential for crown fires but this is dependent on surface fuel loading. Reasons for removal of trees up to 30 inches DBH is generally to reduce stand density and bug induced mortality for forest health. These treatments may have a desired effect on fire behavior especially on steep slopes and in places with extenuating topography or road system circumstances (Safford et al 2009). Omi and Martinson (2002) state that fuels treatments that reduce canopy fuels increase and decrease fire hazard simultaneously and research demonstrates that a reduction in crown fuels outweighs any increase in surface fire hazard. Other recent research supports the claim that there are cases where crown canopy may need to be considered for removal and that strict size diameters do not always meet restoration objectives (North 2009, Collins et al. 2011b).

Flame Length

Alternative 2 reduces the Project area of the potential for flame lengths greater than 11 feet to 1,442 acres (approximately 21 percent of the area, a drop of 10 percent when compared to alternative 1) and to 4,136 acres for flame lengths greater than 4 feet (approximately 59 percent, a 13 percent drop compared to alternative 1). The results are almost identical for both action alternatives, in that the treatments reduce the potential flame lengths in all stands which improve public and firefighter safety throughout the Project area.

The WUI is always given priority to suppression activities. The main reason is the unprotected public is generally found in the urban interface with their homes, businesses, and other possessions. This strategy is defensive in nature and perimeter control is often forgone to protect the urban interface. The results are frequently larger acreage burned, more human improvements and natural resources either threatened or damaged, more firefighters and their equipment needed for suppression actions, and a higher suppression cost.

For fire suppression efforts, the effect of reducing hazard fuels in the WUI is a reduced number of suppression resources needed for structure protection, which allows the resources to be redeployed to perimeter control, thus reducing fire size if fire behavior is controllable. Smaller fires require fewer firefighters, which in turn reduces the number of firefighters exposed to hazards. In addition, smaller fires expose fewer numbers of the public to the hazards of wildfires not only in the urban interface but also in degraded air quality influenced by high-intensity wildfire emissions.

Figure 14 shows the length of time the proposed fuel treatments are effective in meeting the desired conditions as described in Section 1 (flame lengths less than 4 feet). The model starts in the year 2012 and projects the effectiveness of the fuels treatments described in all alternatives for the next 30 years. It assumes that all treatments would be completed by 2022.

Fire Severity

Alternative 2 reduces the potential for high-severity fire (greater than 75 percent mortality) from 25 percent of the Project area (1,767 acres) under alternative 1 to 16 percent (1,104 acres). Figure 16 displays the potential fire severity in acres by alternative once all initial treatments are completed. Figure 17 displays the potential of high severity over time. Alternative 2 reduces this potential over the next decade better then alternative 3 but after 30 years all alternatives have a higher potential for high-severity fire. This figure shows that over time, without maintenance treatments, that fire severity would return to pre-treatment conditions in less than 20 years, but still does a better job after 20 years than alternative 1. After 30 years, modeling shows that that alternative 2 would have increased fire severity over alternative 1; this is partially in part due to the ingrowth of live woody fuels particularly in areas that have been bug killed. Heavy fuel loading with an increase of brush and young trees, if not treated, creates fire intensity levels that are higher than what currently exists in the landscape (Hicke et al. 2012).

Stephens et al. state “in forests that once experienced frequent low to moderate intensity fire regimes, reduction of surface and ladder fuels can create forests with high resistance to wildfire. Therefore, increased use of appropriately designed fuels treatments is recommended in accessible mixed conifer, ponderosa pine and Jeffrey pine forests in the Sierra Nevada…” (2010). While land managers recognize that we cannot completely rely on past forest conditions to give us all the strategies for the future and that restoration of forest structure to resemble those of the past provide no guarantee of sustainability, the restoration of the processes that shaped the forests historically can provide some assurances in maintaining fire-adapted forests (Fule’ 2008 in Stephens et al. 2010).

Therefore, reducing flame lengths through the proposed action would create more resilient conditions where fire acts in a role closer to its natural disturbance process.

Fire Type

Alternative 2 reduces the potential for all types of crown fire (passive, active and conditional surface) by 11 percent over the Project area as compared to alternative 1. Figure 18 below represents the potential type of fire of a wildfire occurring after all treatments have been completed. FVS-FFE modeling for fire type may under represent the potential for passive, active and conditional surface fire as compared to actual fire behavior (Collins et al. 2011b, Cruz and Alexander 2010, Johnson et al. 2011, Keane et al. 2010). Montane chaparral is a major vegetation type within this Project; high-intensity fire in chaparral may have high flame lengths (refer to Table 9 and Figure 7) and still be characterized as surface fires, hence the large number of acres of surface fire in Figure 18.

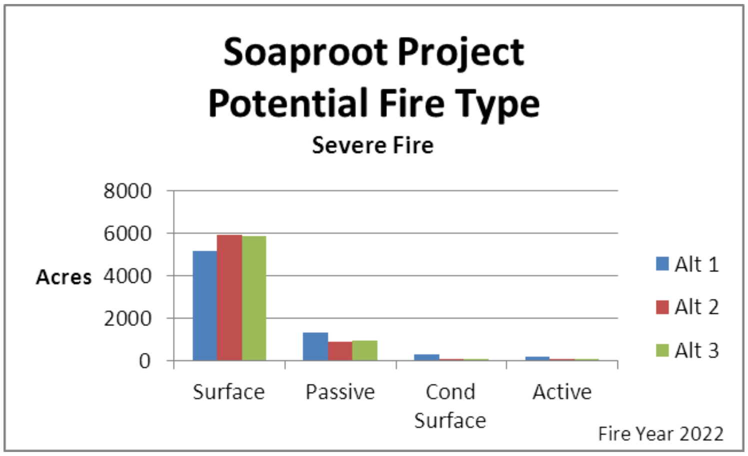

Figure 18. Potential fire type in acres for each alternative.

Indirect Effects

Flame Length

Wildland fires, especially those under extreme conditions (Safford et al. 2009, Safford et al. 2012), threaten homes and increase the likelihood of structures becoming a fuel source. A contrarian position states that WUI defense and threat zones are not necessary and that the only effective way to protect homes from wildland fire is to use non-combustible roofing and other materials, and reduce brush within 100 to 200 feet of structures. This point of view suggests that a leading researcher in home ignitability (Jack Cohen) suggested that only minimal defensible space is necessary and that the FS is ignoring recent research by continuing the use of the WUI threat and defense zones. Jack Cohen has written several papers on home ignitability and the need to address residential structure survivability. The home ignition zone and preventing home ignition falls within the responsibility of the private property owner. In his 2008 paper, Cohen states that "the Forest Service's primary responsibility and objective for structure fire protection is to suppress wildfire before it reaches structure. These findings are consistent with FSM direction, section 5137." Additionally, in a 1998 paper, Butler and Cohen found that thinning trees to produce gaps in the flame front significantly reduces radiant exposure, and that a firefighter' s maximum radiant exposure is well below exposures necessary for piloted wood ignitions. They also found that defensible space requires more vegetation fuel hazard reduction than fuels reductions required for preventing piloted wood ignitions.

Cohen identifies homes as potential fuel and indicates the distance between the wildland fire and the homes is an important factor for structure ignition. His research indicates that home losses can be effectively reduced by focusing mitigation efforts on the structure and its immediate surroundings, and fuel modification need only to occur within 100 to 200 feet from a home (Cohen 1999, Cohen and Stratton 2008). A recent study of the 2007 Angora fire (Safford et al. 2007) at Lake Tahoe, California concluded that for reasons of fire fighter safety that include access and egress, visibility needs, space requirements for movement of machinery and fire crews, and other general requisites, 400 to 500 meters (1,312 to 1,640 feet) is probably the absolute minimum for fuel treatment width in the WUI defense zones (Butler and Cohen 1998, Safford et al. 2009). As Agee et al. (2000), North (2009), and Stephens et al. (2009) found "in forests adjacent to homes or key strategic points, managers may want to reduce fire potential severity under all possible weather scenarios."

California State Fire Codes mandate that flammable vegetation within 100 feet of homes be removed. Fire inspections by local fire departments are normally accomplished once per year. The premise is that once the inspections are completed and the homeowners fire hazards efforts are "approved" the homes should be safe in the event of a wildfire. This is not necessarily the case with homes in forested areas. Fuels accumulate year-round and require constant clean up. A single large pine tree can drop up to three tons of needles every year (Biswell 1999), year-round. Winds produced by a summertime thunderstorm can void a homeowner's hazard reduction efforts by blowing pine needles and branches to the ground and rooftops. These needles and branches are common receptors of flying embers in the event of a wildfire. In reality continued hazard reduction clean-up is needed for homes to be able to stand alone, without the need for firefighting suppression efforts, in the face of a wildfire.

Fire Severity

Recent research (Collins and Stephens 2010) shows that while at some small scale, in frequent fire forest types like those in this Project, high-severity fire would occur at levels that averaged about 10 acre patches, the contentious views that forests are lacking in large acres of high-intensity and high-severity (tree crown mortality) fire is not supported by science (Collins and Stephens 2010, Graham et al. 2004, Miller et al. 2009b, Safford et al. 2012). This contentious view also states that the FS is causing ecological damage by avoiding high-intensity fire. In a frequent fire regime forest (high occurrence of fires with low intensity) the current state of occurrence of high-intensity fires is well outside the range (Graham et al. 2004, Miller et al. 2009b, Safford et al. 2012) of historical FRIs (Meyer and Safford 2011).

Science does show that forests made up of large trees are more resilient to the effects of high-severity fire and that fuels treatments that are designed to remove trees less than 12 inches DBH do a good job of reducing fire behavior (Alexander et al. 2006, Martinson and Omi 2003, Miller et al. 2012, Odion et al. 2004, Omi and Martinson 2002, Safford et al. 2012, and Weatherspoon and Skinner 1995). These same scientists also state there is sometime the need to remove larger trees (12 to 24 inches DBH) to reduce severity: such as on steeper slopes (Safford et al. 2012), to reduce increased tree density to a more historical range to improve resiliency (Collins et al. 2011a, Collins and Stephens 2010, Fule 2008), and to reduce susceptibility to insect epidemic in overly dense stands (North et al. 2009). Collins et al. (2011b) found that conservative fuels treatments (less than or equal to 12 inches DBH) reduce canopy base height for less than 10 years and that that the height to live crown could potentially return to less than the levels under alternative 1 within 20 years. A 10 year or less effectiveness time frame does not meet the purpose and need for the Project and it does not meet the SNF LRMP guidelines for treatments in the WUI (USDA 2004).

Therefore, reducing fire severity through the proposed action would create more resilient conditions where fire acts in a role closer to its natural disturbance process.

Fire Type

Stands structure and conditions still exist where the amount of passive and active crown fire is prevalent over 15 percent of the Project after all treatments have been completed.

An indirect effect of the proposed action is the increased fire resilience of the landscape, which is the ability of the forest to withstand the effects of wildfires (passive and active crown fire) under 90th percentile weather conditions. Collins et al. (2011b) suggest that where the restoration of the historic forest condition (low-intensity/high-frequency surface fires) is the goal, that contemporary treatment prescriptions with respect to residual stand structure may be too conservative. This may be evident in the Project where treatments move the forest toward resilience but do not fully reduce the potential for high and moderate intensity (passive and active crown fires) fire behavior and severity of fires.

Recent research by Stephens et al. (2010) suggests that realignment option (such as the conceptual framework in North's PSW-GTR-220 (2009) could be designed to begin to restore critical structural heterogeneity in forest structure (North 2012). They also suggest that restoration of patterns of burning and forest/fuels structures that reasonably mimic historical conditions prior to fire exclusion is consistent with reducing the vulnerability of these systems to loss (Stephens et al 2010, North 2012).

Cumulative Effects

Cumulative effects are those activities that additively contribute to cumulative impacts on canopy cover, large trees, conifer establishment, resistance to high-severity fire, resistance to insect attack, and ecological restoration conditions from alternative 2 and past, present and reasonably foreseeable activities. These activities include plantation maintenance, past timber projects, vegetation management, fuels reduction, prescribed fire, roadside hazard tree removal, and power line maintenance. In addition, residential development, timber harvesting, and vegetation management is carried out on private land holdings within the cumulative effects boundary.

Cumulatively, the proposed treatments alone and in combination with these other forest restoration projects (See Appendix C) work together to reduce the severity and intensity of wildfires in the Project by reducing flame lengths and fire severity. Fuels reduction treatments directly adjacent to this Project also contribute to the resiliency of the forest as well as move the forest towards the desired condition in terms of fire behavior (flame length reduction), fire type (reduced occurrence of passive and active crown fire), and fire severity (reduced levels of mortality). Some portions of this adjacent landscape (projects on private land within and adjacent to this Project and those projects that are less than 20 years old) have been treated to a level that meet the desired condition of flame lengths less than four feet (USDA 2004). Other areas within the Project are not being treated due to access, species concerns, steepness of slope, adverse risk and/or administrative controls. The past, present, and foreseeable future projects (as listed in the Appendix C) combined with the proposed action move the forest toward a condition that is more resilient to effects of high-intensity/ -severe wildfire. Within the Project boundary, approximately 4,136 acres would still remain with flame lengths greater than four feet, 1,073 acres would still be susceptible to crown fire, and 1,104 acres would still be at risk to high-severity fire effects.

The proposed action, and the East Fork, KREW, Dinkey North, Dinkey South Projects, along with the past actions of the South of Shaver, 10S18 FRP Projects and those on private lands all attempt to shift the landscape towards a more pine and large tree dominated one. All fuels reduction projects less than 20 years old shift fires role toward one closer to the low to mixed severity fire regime experienced historically. These projects reduce the density of trees, increase the resilience to insect attack which alleviates surface fuel loading from bug–induced mortality and cumulatively, these projects bring the landscape closer to a more resilient, historic structure.

While alternative 2 alone would create stand conditions that result in lower fire severity across stands or the whole Project area, these relatively low-severity conditions could be overwhelmed by high-intensity fire in adjacent stands. These results are consistent with observed wildfire effects for treated verses untreated stands (Agee and Skinner 2005, Safford et al. 2009). Model results indicate that recent and reasonably foreseeable activities would reduce fire behavior and lower fire severity across 13 percent of the cumulative effects landscape. However, recent research (Collins et al. 2011b) indicates that 20 percent treatment levels of landscapes are needed to affect large scale high-severity fire and retain tree basal area. The cumulative percent treatment of alternative 2 and recent and reasonably foreseeable treatments is approximately 16 percent.

Approximately 31 percent (about 24,000 acres) of the cumulative effects boundary area contains prescribed fire burn plans or proposals. Approximately 2,000 to 3,500 acres of prescribed fire underburns similar to those proposed in this Project occur each year. The amount of underburns is dependent on weather. Alternative 2 would add approximately one percent more to the cumulative total prescribed fire. However due to administrative constraints (smoke limits, personnel, equipment) the action alternatives would not change the cumulative yearly total of prescribed fire accomplished. Alternative 2 would add approximately one percent more acres with lower fuel loads, higher snag creation, and overall lower brush cover. Once completed prescribed fires cumulatively create a forest condition more consistent with forest restoration desired conditions than the no action alternative.

3.1.2.3. Alternative 3

Direct Effects

Flame Length

The direct effect of alternative 3 is that it raises the height to live crown of the vegetation through ladder fuel treatments. There is less than a two percent difference between alternatives 2 and 3 in terms of wildfire flame lengths and fire behavior (refer to Figure 15) during the first decade. Under this alternative, treatments to remove ladder fuels and reduce height to live crown are immediately effective in reducing flame lengths but treatment effectiveness lasts less than 10 years. Alternative 3 would add about one ton per acre of additional dead and down woody material if the trees between 10 and 12 inches DBH were dropped and left on site or girdled to fall at a later time. Though this amount is minimal, it adds to the already high levels of surface fuel loading that exists in the Project area. If these trees were girdled and left to become snags, they would at some future date become either safety hazards during burning or wildfire operations and increase surface fuel loading. The characteristics of these snags would not meet the large snag criteria for wildlife (SNF LRMP).

Fire Severity

In 2022, the first year after all treatments that can be modeled are completed, alternative 3 would have effects on fire severity that are near identical to the proposed action. There would be 10 more acres of high-severity fire (797 acres for the proposed action versus 782 in alternative 3) and slightly more acres that are modeled to burn at low severity (2,961 acres for the proposed action versus 2,971 for alternative 3). Both action alternatives greatly outperform the no action alternative.

The net direct effect of alternative 3 is to create virtually the same initial fire resilience as the proposed action but far greater resilience than the no action. Alternative 3 has only 20 more acres of high-severity fire as compared to alternative 2. Treatments under alternative 3 are effective for less than 10 years, and due to regrowth of ground vegetation, the height to live crown returns to pre-treatment levels 10 years earlier than alternative 2. This ingrowth increases fire severity back to pre-treatment levels sooner than the proposed action.

Fire Type

There is a less than one percent difference between the action alternatives in the reduction of the amount of acres of post-treatment passive and active crown fire for the first decade. As in-growth occurs and the height to live crown is reduced, the potential for passive and active crown fire increases. The effectiveness of this ladder fuels treatment does not meet the purpose and need of the Project nor does it meet the requirements for fuels treatments in the WUI as defined in the SNF LRMP.

The direct effect of alternative 3 would be that initially it effectively treats the landscape to reduce fire hazard, intensity, and severity; the effectiveness of the treatment lasts less than 10 years compared to the proposed action, in which effectiveness lasts more than 15 years.

Indirect Effects

Flame Length

Height to live crown returns to pre-treatment levels (Collin et al. 2011b) in about seven to 10 years due to increased regrowth in the understory. The regrowth of vegetation and continued stand densities return the Project to a level where wildfire flame lengths would also return to pretreatment levels faster than the proposed action. This alternative does not meet the purpose and need for the Project and does not meet the SNF LRMP that states that fuels treatments in the WUI should be effective for at least 10 years (USDA 2001).

Fire Severity

One indirect effect of alternative 3 is the regrowth in flammable vegetation that is not treated with herbicides (as in alternative 2) would increase fire severity overtime as height to live crown in these areas returns to pre- treatment levels. Alternative 3 has slightly more moderate and high-severity fire behavior within the Project area through time. Potentially, a fire of higher severity could affect the fire severity of adjacent stands as well. Some stands would burn as a surface fire if adjacent stands burn as a surface fire or burn as a crown fire if adjacent stands burn as a crown fire. Therefore the indirect effect of alternative 3 is to cause a slightly greater chance of higher intensity fire across the landscape when compared to the proposed action. Collins et al. (2011b) found that conservative thinning treatments such as those that removed trees less than or equal to 12 inches DBH may result in more restricted access through the stand and limit the amount of woody fuels that would be removed through mechanical treatments such as piling. This restricted access would result in an increased potential for higher severity fire due to increased fire intensity.

Fire Type

Alternative 3 has the potential to have higher intensity surface fire both immediate and long term due to the potential that the conservativeness of the treatment (not removing enough small trees less than or equal to 12 inches DBH) may limit access for mechanical equipment to pile surface fuels. This potential increase in surface fuel loading compared to alternative 2 would result in increased fire intensities and reduced treatment effectiveness.

Cumulative Effects

The cumulative effects of this Project combined with other fuels reduction projects within the landscape have nearly the same cumulative effects overall as alternative 2. While treatments in alternative 3 provide an equal amount of effectiveness as alternative 2 in the first part of the first 10 years, the long-term effectiveness of this alternative is diminished. This affects the overall resilience of the landscape and would not go far enough and the effects of the treatments would not last long enough (less than 10 years) to improve forest health and fire resilience or reduce fire severity and the effects of large scale disturbance. The effects of alternative 3 would not last long enough to meet the purpose and need of this Project in terms of improving firefighter safety, treating fuels that significantly reduce wildfire intensity, or restoring fire adapted ecosystems in terms of moving acres out of unnaturally dense conditions.

3.2. Vegetation and Silviculture

3.2.1. Background and Affected Environment

One of the focuses of the vegetation analysis[11] is to address the effectiveness of each alternative in meeting the purpose and needs for the Project related to restoring the forest vegetation structure consistent with a frequent low-intensity fire regime that historically dominated the Project area. These

[11] The vegetation and silviculture section is a summary of the Vegetation and Silvicultural Specialist Report prepared for the Soaproot Restoration Project. This report is herein incorporated by reference and is available in the Project planning record located at the HSRD office.

forest structures are more resilient to the effects of a variety of human caused and natural stressors like wildfire, insects, disease, air pollution, and climate change.

Another focus of the vegetation analysis addresses the issue raised during scoping related to the validity of removing larger diameter trees (greater than 12 and 16 inches DBH). Through comparison between the proposed action and alternative 3, the varying effects of two different size limits on the various indicators are analyzed. In addition, although these topics are typically addressed in the vegetation analysis, concerns/recommendations that were raised during scoping specifically related to stand density, snags and snag retention, and basal area mortality have been addressed.

3.2.1.1. Forest Structure

A majority of the Project area is ponderosa pine vegetation type. Most individual stands are mostly ponderosa pine, with a smaller amount of montane hardwood/pine, and montane hardwood. Brush or barren vegetation types are also quite common within the Project area. Only six stands have a Sierra mixed conifer vegetation type component. Sierra mixed conifer stands in the Project area are less than 40 percent ponderosa pine.

Vegetation within the Project is a mosaic strongly influenced by past disturbances (timber harvests, prescribed fire, fuels treatments, wind/snow damage and insect mortality), site quality, and secondary succession. The species composition of the Project area is mixed but the largest member, by percentage of total basal area, is ponderosa pine (40 percent of the basal area in the Project area). The three species of oak found in the Project area (California black oak [*Quercus kelloggii*], canyon live oak [*Quercus chrysolepis*], and interior live oak [*Quercus wislizeni*]), together are the next greatest occupier of basal area with a combined 28 percent of the total basal area in the Project area. Based on trees per acre, approximately 75 percent of the oak trees in the Project are canyon live oak, with the remainder of the trees being divided evenly between California black oak and interior live oak. California black oak likely occupies a somewhat larger percentage of the basal area than trees per acre, since it is generally larger than the other two oaks; but canyon live oak likely still dominates the basal area of oaks. Canyon live oak and interior live oak are both shade-tolerant species and together make up approximately 20 percent of the basal area in the Project area. Incense-cedar occupies much of the remaining basal area (24 percent of the Project area), while white fir and sugar pine (*Pinus lambertiana*) are relatively uncommon in the Project, at five percent of the basal area and three percent of the basal area, respectively.

Currently there are approximately 2.5 million trees in the Project area (see Table 11). Of these, about 90 percent are trees 10 inches DBH and under. There are about 470 trees per acre in the Project area, and about 55 trees per acre greater than 10 inches DBH. Of these, only about three trees per acre (16,500 trees overall) are greater than 30 inches DBH and occupy 18 percent of the total basal area for all stands. Trees 10 to 30 inches DBH dominate the stand structure with 62 percent of the total basal area for all stands, or roughly 280,000 trees.

3.2.1.2. Canopy Cover and Brush Cover

Brush cover is found both in the understory and in openings. However, understory brush has less cover due to dense tree conditions. Brush cover ranges from 100 percent (in four stands) to less than 10 percent in one stand (planID 1063). Bear clover and mariposa Manzanita are by far the two most common species of brush found in the Project area, providing for 42 percent and 38 percent of brush cover, respectively. The third most prevalent species of brush by cover is buck brush (*Ceanothus cuneatus*), making up eight percent of the total cover. All other species of brush and small trees (such as hazelnut [*Corylus cornuta*], dogwood [*Cornus nuttallii*], and bitter cherry [*Prunus emarginata*]) are even more minor players.

Tree canopy cover is the percentage of stand area covered by tree crowns. Canopy cover is variable in the Project area. Other than one stand which is dominated by rock (planID 1063) the canopy cover ranges from a high of 91 percent (planID 425) to a low of 14 percent (planID 574). Generally canopy cover levels are high throughout the Project area. Approximately 75 percent of the Project has at least 50 percent canopy cover or higher. The average canopy cover of the Project is 59 percent cover.

3.2.1.3. Snags and Snag Density

Generally large snags[12] are more important to wildlife than small snags[13]. There are on average 5.7 large snags per acre and 14.5 square feet of basal area occupied by large snags. The range of snags per acre is highly variable; one stand (planID 632) had 0 large snags per acre in the sampled areas, while stand 442 had 38.3 large snags per acre. Of the large snags in the Project area, 68 percent have died within the last five years, and 75 percent were ponderosa pine trees.

When all snags are considered, both large snags and small snags, there were a total of 14.1 snags per acre. There was a total of 19.9 square feet of basal area occupied by snags both small and large.

Western pine beetle (*Dendroctonus brevicomis*) caused mortality is currently the primary driver of snag creation in the Project area. Western pine beetle mortality was extremely high in 2010 affecting as many as 419 acres in the Project area (Bulaon and Kiehl, 2011). The size of patches of mortality caused by western pine beetle has also been growing (see Figure 10 and Figure 12 for an example).

3.2.1.4. Stand Density

Stand density index (SDI) is a relative measure of tree density that compares existing tree density to a reference maximum density. SDI values beyond 35 percent of the reference maximum density indicate that site resources are at a “limiting density” for tree growth and vigor. SDI values beyond 60 percent of the reference maximum indicate that site resources are at the “lower limit” at which tree mortality from insect attack or inter-tree competition for water, soil, light, nutrients is imminent.

Twenty-six percent of the Project area is dominated by SDI above the lower limit of self-thinning (60 percent of maximum). Fifty percent of the Project area is between 35 to 60 percent of maximum SDI or at moderate risk to density or insect mortality. Fourteen stands within the Project area are dominated by areas at high risk to insect or density mortality. Seen another way these stands have more than 50 percent of acres subject to density or insect mortality.

Insect, disease, and density induced mortality is disproportionately effecting ponderosa pine species. Observations within the Project area indicate that bark beetles continue to kill pine. The current trend in mortality and tree regeneration indicate that pine species are declining while shade-intolerant oaks and incense-cedar are increasing in dominance.

3.2.1.5. Indicators

The effects of the alternatives were evaluated using the indicators below.

[12] Large snag is defined in this report as a dead tree 15 inches in DBH or greater and at least 10 feet tall.
[13] Small snag is defined in this report as a dead tree between 5 to 14.9 inches DBH and at least 10 feet tall.

Indicator 1: Canopy Cover and Brush Cover

Canopy cover does not have a uniform desired condition, based on the particular area canopy cover desired condition can vary. High canopy cover is one of the primary habitat requirements of several wildlife species including Pacific fisher and California spotted owl (Zielinski et al. 2004 and Bias and Gutierrez, 1992). The SNF LRMP identifies 50 percent canopy cover as a critical threshold for spotted owl and pacific fisher. However, the reduction of bulk canopy density is highly correlated with reduction of active crown fire (Agee and Skinner, 2005). The SNF LRMP also repeatedly mentions the openness of the canopy as a desired condition for WUI defense areas. The acres above 50 percent canopy cover are analyzed for this indicator.

Changes in brush cover will also change understory canopy cover. The percentage of brush cover in the general forest is also analyzed for this indicator.

Indicator 2: Trees per Acre

Trees per acre is one method of looking broadly at the structure and density of a stand. Trees per acre greater than 10 inches DBH provides an indicator of the dominance of large trees. Large trees provide future wildlife habitat and are more resistant to the effects of fire. Based on the historical conditions and present management constraints, the desired management variability is between 15 and 40 trees per acre greater than 10 inches DBH and reduced small trees sufficient to break ladder fuel continuity. This indicator is measured through the trees per acre removed by size class, and the trees per acre through time.

Indicator 3: Tree Species Composition

Ponderosa pine, sugar pine and California black oak are found at lower frequencies than the historical Sierra Nevada forest subject to a frequent low-intensity fire regime (Bouldin 1999, Taylor 2004, North et al. 2004). Ponderosa pine and black oak grow best in full sunlight (shade-intolerant). As stand densities have increased (more shade) ponderosa pine, black oak, and sugar pine have been reduced in abundance with increases in fir species. Encouraging the growth of pines and oaks will restore structures to those consistent with a historic fire regime. The stem proportion of pine (basal area in square feet) is used to compare alternatives. In addition, the conditions for the growth of shade-intolerant species are assessed.

Indicator 4: Large Tree Basal Area

There is no science based definition of large tree size. The public has identified a concern with maintaining trees over 12 inches, 16 inches or 20 inches DBH. Restoration under the proposed action proposes to keep sufficient intermediate size class trees (20 to 30 inches DBH) to provide for future large trees consistent with ecological restoration (North et al. 2009) or pre-1850 forests. Alternatives are compared on the numbers of trees removed from diameter classes.

Frequently trees above 35 inches are considered “large trees” on the HSRD, because that is the diameter level where trees become rare and occupy a small portion of the basal area. The Project area has fewer large trees than many other parts of the HSRD, and the proportion of basal area occupied by trees greater than 30 inches in DBH is limited. Therefore trees greater than 30 inches are considered large.

Alternatives are compared in the proportion of large tress (over 30 inches DBH) over the 30 year analysis period.

Indicator 5: Snags

Snags are an important structure used by wildlife and an important element of diversity and heterogeneity within stands. Generally snags larger than 15 inches DBH are considered important to wildlife and the analysis is focused on snags of this size. This indicator is analyzed through snags per acre levels through time.

Indicator 6: Stand Density Index

As SDI increases beyond 35 percent of maximum (limiting density) insect mortality is possible (Oliver 1995, Oliver and Uzoh 1997, Sherlock 2007). When stand density increases beyond approximately 60 percent of maximum (lower limit of self-thinning) insect or density mortality is imminent. These zones for the onset of tree stress do not predict when a tree or clump of trees will be attacked. This uncertainty of when a tree or clump will be attacked is due in part to the unpredictable nature of drought and the random dispersal of insects. SDI is used to display effects of alternatives on reducing the potential for insect mortality and reducing tree stress. This indicator is analyzed by looking at the percentage of maximum SDI in each stand, with a focus on the 35 percent of maximum and 60 percent of maximum thresholds.

Maximum SDI levels used were the default levels in FVS (Keyser 2008). These levels vary by species; for the species common in the Project area they are 759 for white fir, 571 for ponderosa pine, 706 for incense-cedar, 382 for California black-oak, 624 for other softwoods (which includes lodgepole pines [*Pinus contorta*]), and 647 for sugar pine. Although Oliver (1995), indicates that the limiting SDI for even-aged ponderosa pine is actually 365 when *dendroctonus* bark beetles are involved, this was not used as the limiting level in this modeling. The use of the FVS 571 allows for a comparison of both insect and density induced effects on tree vigor and risk to insect attack.

Indicator 7: Competing Vegetation (herbicide use)

Conifer seedling survival and growth are closely linked to the amount of shrub cover and available water. More brush cover results in less water available for conifer survival and growth. This indicator reflects the purpose and need to establish shade-intolerant conifers and oaks. When brush cover exceeds 15 percent, conifer survival drops quickly (McDonald and Oliver 1983, McDonald and Fiddler 1989). This indicator compares the effects of brush cover on conifer and oak seedling survival and growth with and without treatment.

3.2.2. Environmental Consequences

3.2.2.1. Alternative 1 (no action)

Direct Effects

There are no treatments under the no action alternative and therefore, there are no direct effects related to vegetation.

Indirect Effects

Canopy Cover and Brush Cover

Since alternative 1 would not implement specific activities to reduce tree canopy cover, unplanned events play the greatest role in controlling canopy cover. Indirect effects would occur as a result of tree growth and mortality.

With no unplanned events, such as fire or insect attack, the indirect effect of the no action alternative results in areas with greater than 50 percent canopy cover increasing from approximately 3,650 acres (67 percent) in 2012 to 4,200 acres (77 percent) in 2022. Beyond 2022, this trend is expected to continue, reaching approximately 4,500 acres (84 percent) by the end of the 30 year analysis period. Only the densest stands would lose canopy cover as a result of mortality due to competition for water, nutrients, and light.

Understory brush would be reduced in cover and height in the no action alternative. In the absence of disturbances such as insect attack or severe fire trees would continue to grow. As overstory tree canopy cover increases over the analysis period, brush growth would slow and brush cover would reduce. Therefore, the indirect effect of the no action alternative is when full crown closure occurs, brush species would be reduced to scattered individuals or small clumps of brush.

Trees per Acre

Natural recruitment (seedling establishment) and tree mortality through time control the indirect effects of the no action alternative on the amount of trees per acre. Due to the already dense conditions in the Project area, as well as the extensive brush cover, recruitment of new trees would likely be minimal in the future. As previously mentioned there are currently high levels of insect mortality in the Project area related primarily to high density levels (Bulaon and Kiehl, 2011). Without thinning, this mortality is likely to continue unabated or even increase in severity. Mortality can also be expected as a result of inter-tree competition.

The net indirect effect of the no action alternative would be a six percent decline in the total number of trees between 2012 and 2022. This declining trend would continue beyond 2022, staying at a rate of approximately five percent per year. The number of trees greater than 10 inches in DBH is expected to grow between 2012 and 2022 increasing from 54 to 61 trees per acre. Trees per acre greater than 10 inches DBH are expected to remain relatively steady after 2022. The modeling assumes mortality due to bark beetle stays at current levels. However, the rate of bark beetle mortality could increase from current levels, particularly if there was a drought event. Since the western pine beetle preferentially kills trees greater than 10 inches DBH, bark beetle mortality could be higher than modeled. This increase in mortality would likely decrease the amount of trees greater than 10 inches quickly within the Project area.

Tree Species Composition

Conditions presently effecting species composition, such as high density, low levels of light penetration to the canopy floor, high levels of air pollution, high levels of bark beetle driven mortality and absence of characteristic low-intensity fire are likely to continue or become higher intensity through time under the no action alternative. These conditions favor establishment of incense-cedar, live oak, and where present, white fir; these conditions disfavor ponderosa pine, California black oak, and sugar pine establishment. Furthermore, the western pine beetle is tree species specific and (of the trees found within the Project) will only kill ponderosa pine. Fir engraver beetle (*Scolytus ventralis*), which selectively kills white fir, and mountain pine beetle (*Dendroctonus ponderosae*) which selectively kills sugar pine are also present in the area, but they are overshadowed in activity by western pine beetle (Bulaon and Kiehl, 2011). Sugar pine is also targeted by the non-native white pine blister rust (*Cronartium ribicola*) in the Project. Mature California black oak depends on openings and less dense areas to survive, as it does not tolerate growing underneath heavy overstory. The combination of conditions unfavorable for pine recruitment and pine survival, combined with conditions favorable for shade-tolerant species recruitment, create a synergy of indirect effects. These indirect effects under the no action alternative would continue to push the species composition toward incense-cedar, live oak, and white fir and away from ponderosa pine, California black oak, and sugar pine.

Modeling confirms these indirect effects of the no action alternative through time. Ponderosa pine is modeled to increase by one percent of the total basal area between 2012 and 2022 (40 percent of total basal area to 41 percent). After 2022, ponderosa pine is modeled to trend downwards through time reaching a modeled 32 percent of total basal area by 2042. Since FVS does not distinguish between California black oak and other live oaks it is difficult to analyze oak trends through time. Between 2012 and 2022, total basal area for oak in the Project is modeled to decline three percent (28 percent to 25 percent). After 2022, levels are modeled to stay relatively level. For reasons already described, it is likely this is the loss of California black oak coupled with the rise of live oaks. On the other hand, incense-cedar and white fir both increase in percentage of total Project basal area occupied every year, increasing from a combined 28 percent to 30 percent from 2012 to 2022, and up to a combined 36 percent by 2042.

Large Tree Basal Area

Restoration of forest structures, especially the number of large trees, requires time to develop and a period free of stand-replacing events. The no action alternative maintains trees in dense stands providing limited growing space for diameter and crown expansion. Stand density is highest under the no action alternative. The no action alternative retains a smaller proportion of stem area (basal area) in large trees compared to either action alternative in each growth period. Still, the net indirect effect of the no action alternative would be that trees larger than 30 inches would increase in stem area without wildfire from 18 percent to 22 percent in 2042.

Low-intensity wildfire and insect attack could benefit the accumulation of large snags, large trees, and reduce understory vegetation. However, stand conditions lend themselves to high-intensity fire. The no action alternative in the absence of severe wildfire retains less stem area in large trees than the action alternatives. When severe wildfire enters the Project area, large trees are lost and the no action alternative has far less stem area in trees greater than 30 inches than the action alternatives. Furthermore, if western pine beetle mortality continues to increase in intensity, as is possible under the dense conditions of the no action alternative, the proportion of large trees would be reduced, since bark beetles generally prefer larger trees.

Snags

Modeling predicts that the indirect effect of the no action alternative would be, by 2042, a 58 percent increase in the amount of snags from present levels. In 2032, the number of snags doubles from 2022.

A wildfire moving through the landscape would undoubtedly change the numbers generated by the modeling greatly. If such a disturbance occurred, snags per acre would rise quickly in the short run, however, several years after the disturbance took place the large standing snags per acre in the area which was disturbed would drop to near zero levels (Passovoy and Fulè, 2006). This is because the large snags created by the disturbance would eventually rot and fall; and the disturbance would have removed most of the pool of large diameter trees which could become large snags.

Stand Density Index

The no action alternative allows stands to increase in stand density. This increase is due to both the increase in size of existing trees and the growth of new trees filling in canopy gaps. New trees would be mostly those trees that do well in shade such as incense-cedar and white fir. Portions of the Project area that are resilient to insect attack (below the lower benchmark of 35 percent of maximum SDI) are approximately 25 percent. Twenty-five percent of the Project area is over the upper benchmark of 60 percent of maximum SDI (Figure 21). In 2022, the amount of acres resilient to insect attack (below 35 percent SDI) is modeled to decrease to 20 percent whereas the amount of acres above the 60 percent SDI level are expected to increase dramatically to 42 percent. Beyond 2022, the acres below the 35 percent SDI continue to decrease (to 10 percent by 2042), whereas the amount of acres above 60 percent SDI are expected to stay steady or decrease moderately (down slightly to 40 percent by 2042). As stands begin to exceed the benchmark densities for imminent mortality (60 percent of SDI), individual stress and disease weakened trees would begin to die. Pine species would see continued mortality with fir species experiencing mortality as more acres move beyond the high risk threshold. The indirect effect of growth and increased density under the no action alternative is that the level of insect risk and likely insect mortality would increase over time within the Project area.

Currently, there are endemic and growing mortality levels caused by bark beetles in the Project area (Bulaon and Kiehl, 2011). The Bulaon and Kiehl (2011) report predicts that mortality levels would grow without action in the Project area. While mortality would reduce tree density, unplanned insect mortality would not be achieving the purpose and need of the Project.

Historical weather data indicates that the Sierra Nevada experiences periodic droughts (McKelvey et al. 1996, North et al. 2005). In below normal precipitation years, lack of water would weaken tree resistance and allow bark beetles to begin causing mortality in pockets. The mortality would likely exceed the periodic growth rate of stands (Oliver 1995). Dead trees would eventually contribute to the fuel load and secondary succession would result in the early dominance of created openings by brush species.

Epidemic mortality from bark beetles observed in the area in the late 1980s exceeds modeled density-induced mortality within the analysis area, and is increasing dramatically within the last five years (Bulaon and Kiehl, 2011). Since 1960, each decade has seen significant occurrences of bark beetle mortality within the HSRD. No clear risk model for western pine beetle in the Sierra Nevada exists. However, it is certain that stand and weather conditions as described in the previous paragraph that result in stand-replacing insect mortality would persist in the analysis area under the no action alternative.

Controlling Competing Vegetation

Existing openings are not reforested under alternative 1. Unplanned events such as wildfire and bark beetles create openings in the forest canopy. No planting of these openings or existing openings created from unplanned events would occur. Reforestation would rely on secondary succession to reforest following unplanned events. These openings would likely continue to be dominated by brush similar to untreated stands examined in research (McDonald and Fiddler 1995). McDonald and Fiddler (1995) found that Sierra Nevada forest areas dominated by brush species required treatment to return conifer dominance. In another study, McDonald and Fiddler (1997) found that areas that lacked treatment to reduce manzanita or *Ceanothus* had changes in the dominance of brush species through time, but brush continued to dominate and increased in dominance over 31 years.

Many studies have shown clearly that brush competition slows the growth of conifers (Tappeiner and Radosevich 1982, McDonald and Fiddler 1990, McDonald and Fiddler 1995, McDonald and Fiddler 1997, Tappeiner et. al. 1997, McDonald and Fiddler 2001, McDonald et al. 2004, Powers et al. 2004). Conifers that do become established in the no action alternative could be up to two times shorter and thinner where bear clover, *Ceanothus*, and green leaf manzanita (*Arctostaphylos patula*) compete with conifers (Tappeiner and Radosevich 1982, McDonald and Fiddler 1997, McDonald and Fiddler 2001).

Thus conifer establishment under the no action alternative would result in very sparse numbers of trees and openings dominated by bear clover, manzanita, or *Ceanothus*. In those openings that favor conifer establishment, high tree density would occur (McDonald and Reynolds 1999). New conifer establishment would continue to be dominated by shade-tolerant species, incense-cedar, live oak, and at higher elevations white fir, as these species grow under the shade of brush and other trees. Growth of conifers that would occur in these small openings would be slow (McDonald and Reynolds 1999) but dependent on site factors. It is not that conifers would not become established under alternative 1, but rather that conditions that promote the establishment of shade-tolerant and lower fire resistant incense-cedar and fir would continue. The growth of these shade-intolerant trees would be slow due to brush and high tree density.

Cumulative Effects

The no action alternative has no Project activities and there for there are no cumulative effects to vegetation under this alternative.

3.2.2.2. Alternative 2 (proposed action)

Direct Effects

Canopy Cover and Brush Cover

Reductions in canopy cover result from tree removal. Canopy cover greater than 50 percent is an important habitat component for California spotted owls and Pacific fisher (Verner et al. 1992, Zielinski et al. 2004). The SNF LRMP indicates canopy cover above 50 percent in California spotted owl PACs and 40 percent in HRCAs consistent with fire and fuels objectives. Maintaining canopy cover over 50 percent is used to compare effects on vegetation between alternatives. In addition, canopy density has been shown to have a relationship to fire behavior and severity (Jain and Graham 2004). Higher canopy density indicates a higher potential for severe fire. Changes in canopy cover resulting from mechanical tree removal, hand treatments, and prescribed fire are addressed in this section.

In 2012, of the 53 stands currently above 50 percent canopy cover, the proposed action would reduce the canopy cover below 50 percent in 10 stands. Mechanical treatments in 2012 would reduce the average tree canopy cover across the treated stands from 61 percent to 55 percent. All stands above 40 percent canopy cover within spotted owl HRCAs would remain above 40 percent; stands above 50 percent canopy cover in spotted owl PACs would remain above 50 percent. There are approximately 4,183 acres above 50 percent canopy cover in the no action alternative compared to 3,207 acres above 50 percent canopy cover after all treatments in the proposed action are completed in 2022. This is about a 976 acre reduction. The direct effect of alternative 2 would be that the least acres above 50 percent canopy cover would be maintained, when compared to the other alternatives.

Several activities in the proposed action would have direct effects on brush cover within the general forest. Direct effects would include reductions of above ground cover and cubic feet per acre and would occur through mastication, tractor piling, grapple piling, hand cutting, and underburning. Below ground root systems would be disrupted or killed through tractor piling (brush rake) and underburning. Each treatment has a differing effect on the species capable of sprouting.

Underburning can reduce both the above ground green leaf manzanita stems and below ground roots. Underburning however also stimulates sprouting (Kauffmann and Martin 1990). In a study of burning in the Sierra Nevada mixed conifer, results indicated that spring burning had the most sprouts, while fall burning results in the most plant mortality. Monitoring results from two underburns on the HSRD indicate that 53 percent and 62 percent of existing brush canopy cover was killed in these burns. However, the typical HSRD spring burns are not effective in killing the root systems of sprouting species. This is due to the biological defense to fire that plants have evolved and the low intensity of underburns. Similar results can be expected in other action alternatives.

Trees per Acre

Table 11 below summarizes the removals of trees by size class for alternative 2.

Table 11. Tree figures across all treated stands (including stands receiving prescribed fire only) for alternative 2.

Alternative 2 –proposed action (thousands of trees)						Average Trees per Acre			
DBH Class	0" to 10"	10" to 20"	20" to 30"	over 30"	Total	under 10"	10" to 20"	20" to 30"	over 30"
Existing trees	2243.2	225.1	51.7	16.4	2536.5	414.7	41.6	9.6	3.0
Mechanical Treatment Tree Removals	718.5	12.6	2.8	0.0	733.9	132.8	2.3	0.5	0.0
Percent removal	32%	6%	5%	0%	29%	n/a	n/a	n/a	n/a
Percent remaining	68%	94%	95%	100%	71%	n/a	n/a	n/a	n/a

Before treatment, there is an average of 469 trees per acre over the 5,409 acres of stands which receive direct treatment. Immediately after stands would be treated mechanically or by hand, but before underburns in 2017 are simulated, there are approximately 333 trees per acre on the average. In year 2022, the earliest year after all treatments would be completed and that has modeled output available, there are 314 trees per acre. This is 125 trees per acre less than the 440 trees per acre modeled in the no action alternative for 2022. The reduction in trees per acre is especially pronounced when focused on the 1,605 acres treated with hand or mechanical tree removal. In these areas, in 2012, stand density drops from 600 trees per acres under the no action alternative to 218 trees per acre under the proposed action.

The identified desired condition for the Project is a maximum of 40 trees per acre greater than 10 inches DBH. Tree removal drops average trees per acre in treated areas to 51 trees per acre greater than 10 inches DBH compared to 54 trees per acre in the no action alternative. Reductions of trees per acre above 10 inches DBH are fairly minor, especially compared to historical pre-European levels. When the proposed action is compared to either the no action alternative or alternative 3, the numbers of trees and the growth of large trees overtime do suggest that the proposed action is slightly closer to a trees per acre level found in historical forest structure.

In existing openings, consistent with the design criteria, 300 to 450 trees per acre would be established. HSRD records indicate that typical seedling survival rates in similar forests types are above 80 percent. Rock and other obstructions reduce the total number of spots available for planting. Thus a planting spacing of 10 feet between seedlings or 17 feet between spots with three seedlings yields 435 gross seedlings per acre inside gaps or openings. Typically rock and obstructions limit plantable soil by 20 percent. Eighty percent survival and 80 percent plantable soil yields approximately 278 seedlings within a one acre opening. Planted existing openings can occupy up to 10 percent of stands. Thus planted seedlings would contribute approximately 28 trees per acre across any stand. In areas in which planting would occur under the proposed action, ponderosa pine and sugar pine (rust resistant) would be favored by planting species priorities. Natural regeneration would be allowed and encouraged.

Existing openings would be reforested under the proposed action alternative. Planting of seedlings, thinning and prescribed fire have effects on trees per acre. Reforestation would occur to alter the species and the number of trees found in openings. Some openings would likely continue to be dominated by brush. Planting and release treatments would insure the establishment of trees. Tree dominance would increase over the 30 year analysis period.

Conifer establishment and thinning combined under the proposed action would result in fewer trees generally, but add additional trees of desirable species in openings. This would change tree numbers in the area of openings. Growth of conifers that would occur in these small openings or adjacent to openings would increase (McDonald and Reynolds 1999) but this increase would be dependent on site factors.

The direct effect of the proposed action would be that the most trees per acre would be removed out of all the alternatives, although some trees would be established through planting or thinning.

Tree Species Composition

Under the proposed action, shade-tolerant trees including incense-cedar and white fir are highest priority for removal. In openings that are targeted for conifer establishment, live oak trees would also be targeted for removal. Pine trees, in particular ponderosa pine, are the highest priority for retention. This removal/retention priority would have the direct effect of shifting the proportion of trees away from shade-tolerant and towards pine. Prescribed fire selectively kills the less fire resistant small incense-cedar and fir trees, and would be less likely to kill the more fire resistant pine. The proposed action would attempt to modify existing canopy openings, under stocked areas of plantations, and plant pine seedlings. Other treatments (site preparation, hand release, chemical release, and reorientation of existing openings) would have the effect of making openings more favorable for pine establishment and planting pine trees.

In the year 2022, the soonest year after all treatments are modeled and basal area is reported by species, 44 percent of the basal area would be occupied by ponderosa pine compared to 42 percent under the no action alternative (an additional three percent of the basal area would be occupied by sugar pine in both alternatives). This increase is due to the growth of existing ponderosa pine and removal of incense-cedar and white fir. Incense-cedar and white fir occupy a combined 28 percent of the basal area in the proposed action and a combined 30 percent under the no action alternative. The increase in pine species is not dramatic; the lack of pine species increase is due to the proposed action removing mechanically only six percent of the trees 10 to 30 inches DBH and no trees which are larger (besides hazard trees). Prescribed fire is also not expected to have a large effect on trees greater than 10 inches DBH. In other words, neither mechanical operation nor prescribed fire is expected to remove or kill very many medium or large trees. Trees 10 to 30 inches DBH occupy the largest portion of the basal area. Therefore, the direct effect of the proposed action would be a very moderately increase in the basal area occupied by pine and a very moderately decrease in the amount of incense-cedar and white fir compared to the no action alternative.

Large Tree Basal Area

The proposed action generally focuses on removing trees between 0 to 30 inches DBH in restoration areas and trees generally less than 16 inches DBH in ladder fuel areas. Along roads and adjacent to electrical transmission lines, hazardous trees larger than 30 inches DBH are removed. Thus the proposed action only directly affects the basal trees less than 30 inches DBH or less than 16 inches DBH depending on the objective of the area. For a breakdown of tree removals by size class see Table 11.

Alternative 2 thinning would remove approximately 0.5 trees per acre from 20 to 30 inches DBH or approximately 2,800 trees across the Project area. Tree removal in intermediate size trees (20 to 30 inches) would occur to meet the objectives of increasing or maintaining pines, increasing proportion of large trees, creating stand and landscape heterogeneity, and increasing the growing space for remaining trees, especially large ones. Since the removal of small trees would reduce the fuel ladders that threaten the persistence of large trees during a wildfire event or during underburning, the direct effect would be an increase in the likelihood that these large trees will survive. This is consistent with published research that indicates that understory thinning and individual tree selection treatments directly benefit the protection of large trees (Agee and Skinner 2005, Kolb et al. 2007).

By removing small tree basal area, the percentage of basal area occupied by larger trees would increase (since the large tree basal area remains unchanged but the total basal area decreases). In 2022, 22.4 percent of the basal area is occupied by trees greater than 30 inches DBH under the proposed action, compared to 19.4 percent in the no action alternative. The direct effect of the proposed action would be a moderate shift in the basal area to larger trees.

Snags

Snags greater than 30 inches DBH would only be removed should they be hazardous to roads or electrical transmission lines. In restoration treatment areas, the effect on large snags depends on the WUI status. Within WUI defense zones the four largest snags per acre would be left, within WUI threat zones the five largest snags per acre would be left, and in areas outside the WUI the six largest snags per acre would be left. All other snags between 15 to 30 inches DBH would be removed under the proposed action.

Prescribed fire operations would likely add large snags to the Project area. Though there are design criteria to minimize mortality to the overstory from prescribed fire, it is not possible to prevent all mortality. Scientific literature for the Sierra Nevada found underburning alone created roughly two more large snags per acre compared to the control (Stephens and Moghaddas 2005, Innes et al. 2006). Other research analyzing the effects of prescribed fire on the HSRD indicate that a 12 percent loss of large snags (greater than 22 inches) was experienced in both mixed conifer (Innes et al. 2006) and ponderosa pine stands (Bagne et al. 2008). This same research indicates increases in smaller snags of over 25 percent. These results reflect short-term direct effects from two burns. It is expected that while short-term effects on large and small snags may be similar, long-term mortality would likely result in little change or an increase in large snags resulting from prescribed fire.

Stand Density Index

The direct effects of alternative 2 would be to remove or kill trees and thus reduce the number of acres above the high density mortality threshold. Alternative 2 does not eliminate the potential for insect attack or disease. In 2022 under the proposed action, 22 percent of the acres within treated stands continue to have high index and mortality risk, compared to 42 percent in these same acres in the no action alternative. Looking only at those stands which receive mechanical treatment, the contrast becomes even greater, with 12 percent of the acres being at high risk for insect mortality under the proposed action. Modeled results would indicate that the creation of snags important for wildlife habitat would continue across the Project. This is especially true in fisher rest site clumps that are maintained at densities above the threshold for imminent insect attack and self-thinning. Proposed action treatments have much more acres resistant to density induced and insect attack than the no action alternative.

The proposed action would reduce tree stress by increasing available water, which would lower the potential for insect attack. This improved tree vigor also occurs for large pine trees (Kolb et al. 1998, Kolb et al. 2007). Density reduction does not eliminate the potential for insect attack or self-thinning. Insects would continue to play a role in shaping stand structure. A study that compared thinned and un-thinned stands of ponderosa pine demonstrated an increased resistance to insect attack from thinning over a 32-year study period (Kolb et al. 1995). While stand structures would be more open, dense portions of stands would exist across the landscape: fisher rest sites, areas burnt in patchy manner in the prescribed burning, and other untreated areas. These individual trees and pockets of trees would be vulnerable to insect attack. Insects would cause mortality creating snags and habitat. This is consistent with what has been observed in mixed conifer stands with frequent fire regimes analogous to the Project area (Maloney and Rizzo 2002). In open mixed conifer stands that have continued to experience low-intensity fire similar to what occurred in the Project area, insect activity was very low and tended to kill large old trees. This loss of old trees occurred because old trees are less vigorous (Kolb et al. 2007), and the loss occurs even though they are well established and have access to water held deep in the soil or bedrock (North et al. 2007).

Controlling Competing Vegetation

Gaps are by nature small openings in the forest canopy. Past experience indicates that some are distinct and can be mapped, most however are small and only found after field review. Gaps are subject to the effects of secondary succession; however because of the small size, gaps have more forest edge relative to the opening. This results in the neighboring intact forests having a strong influence on the growth of vegetation in the gap (York et al. 2004). Existing openings (gaps) created from insect, disease, past harvest or fire mortality are the emphasis for regeneration or brush retention. The action alternatives incorporate decision criteria to identify when regeneration would occur or brush retained.

The direct effects of the proposed action would be that openings (gaps) would be located and these areas would be prepared as groups for the regeneration of conifers and oaks consistent with the regeneration treatments or a reduction in the age class of brush would occur through brush treatment. The variability of gaps results in a variable size distribution. Past HSRD experience with small opening regeneration is similar to those proposed under alternatives 2. Field review of the Project area identified a range of existing openings suitable for regeneration from 0.1 to three acres. Many smaller openings occurred, but were not measured. Natural regeneration has occurred in these small gaps. Previous planting and natural regeneration in the Project area has resulted in conifer regeneration in openings ranging from less than one tenth of an acre to two acres. For more information on planting in terms of the spacing, species composition, or number of trees that would be established, see Trees per Acre section, above.

Besides planting, alternative 2 proposed other treatments to control competing brush around seedlings. These treatments release planted conifers and thin along the edges of openings to reduce shade. In these less shaded conditions the reforestation of openings would favor the survival and growth of pine species. Lilieholm et al. (1990) found that ponderosa pine was not present under a heavy overstory in unmanaged stands; active management is often necessary to create conditions for shade-intolerant pine. The direct effect of alternative 2, planting in openings, control of brush, and reducing edge trees would be the creation of an environment suitable for establishment and growth of shade-intolerant species. Alternative 2 retains brush in 10 percent of existing openings and retains up to 15 percent brush in plantation areas.

Treatments that remove only the above ground stems of sprouting species would not significantly change brush cover within a couple years of treatments. However, the above ground removal reduces the size of plants and reduces leaf cuticle thickness. Both these results make subsequent chemical treatments more effective. Tractor piling serves to disrupt below ground roots; it reduces the mass of roots, but stimulates sprouting.

Alternative 2 treats bear clover where it competes with planted seedlings in openings by a directed backpack spray of glyphosate and surfactant. Two applications of glyphosate have been typically required to reduce bear clover cover below 20 percent. The direct effect of this treatment would be killing both above ground stem and the below ground rhizomes of bear clover. Bear clover is seldom eliminated from an area treated with glyphosate. Grasses often invade areas with reduced cover of bear clover and other brush species. Grasses are effective competitors for site resources. The second application of glyphosate would also control invading grass species.

Green leaf manzanita and major *Ceanothus* species found within the Project are sprouting species and can also germinate from seed stored in the soil. Direct effects on *Ceanothus* species and green leaf manzanita would be reductions of above ground cover through mastication, tractor piling, hand cutting (chainsaws and manual release), and underburning. Below ground root systems would be disrupted or killed through tractor piling (brush rake), underburning and chemical application. See Canopy Cover and Brush Cover section above for more information on underburning effects on brush cover.

Glyphosate chemical spraying of *Ceanothus* species is most effective when sprayed on small and tender plants. Hand cutting is planned for the control of buck brush or deer brush seedlings where plants are less than two feet tall. Manual release of *Ceanothus* is ineffective on large plants or large roots. Alternative 2 treats existing large plants through cutting or shredding (mastication). A follow up spray of glyphosate and surfactant (R-11) are used to kill the large root systems.

Non-target plant species are likely to be killed by proposed treatments (see Botanical Resources section). This is true for both mechanical and chemical treatments. Both the mechanical and chemical treatments are proposed for stands that will contain a mosaic of both understory vegetation and logging residue. Mechanical treatments while directed at larger woody plants and removal of logging residue would tend to treat all brush species found in areas available for treatment (outside of SMZs, owl nest buffers, and protected brush openings). In areas proposed for chemical treatments, the intermixing of target and non-target species results in the non-target species being killed. However, past experience and research indicates that non-target species are not eliminated from treated stands (McDonald and Fiddler 1995).

In areas infested with non-native Spanish broom, Spanish broom would be sprayed with Garlon© herbicide applied at label rates. Some non-target brush may be directly killed through this herbicide treatment. However, through time, brush and planted ponderosa pine would be encouraged in the area; for more information see the botany specialist report (Tuitele-Lewis 2012).

Indirect Effects

Canopy Cover and Brush Cover

Indirect effects on canopy cover would be those that occur as a result of growth or mortality following proposed treatments. Alternative 2 would reduce canopy cover on several hundred acres as a result of both tree removal treatments and underburning. However, trees that remain following tree removal would reoccupy growing space and increase canopy cover with time.

Acres of canopy cover over 50 percent increases over the 30 year analysis period following thinning in all action alternatives. After 30 years, alternative 2 produces approximately 3,207 acres with a canopy cover over 50 percent. This is approximately 284 acres less than alternative 3 and approximately 1,320 acres less than the no action alternatives. The indirect effect of the proposed action would be the least acres of tree canopy over 50 percent produced after 30 years without fire.

Due to more open conditions directly created by the proposed action, brush cover would likely increase through time. For example, increases in growth and cover of manzanita, bear clover and other brush species can be expected following the reduction of overstory canopy cover. Although there are several direct effects which would decrease brush cover in the short term, root sprouting shrubs would not be impacted by these treatments in the five to 30 year term. Combined with the more open conditions created by the proposed action, outside of openings which are being planted, brush would likely increase in cover generally.

Trees per Acre

Figure 19 below shows the trends of trees per acre for all size classes over time in areas hand or mechanically thinned. Modeling for 1,605 acres which receive mechanical or hand thinning, shows that in 2042, the trees per acre under the proposed action would increase to 275 trees per acre without further treatment. This is compared to the 501 trees per acre in 2042 in the no action alternative over these same 1,605 acres. Further treatments, requiring future decisions, could continue to maintain and improve upon the trends established by the proposed action towards ecological restoration.

The indirect effect of the proposed action would be that it have the least amount of trees per acre of all alternatives throughout the 30 year modeling period; however, the amount of trees per acre grows through time in the proposed action.

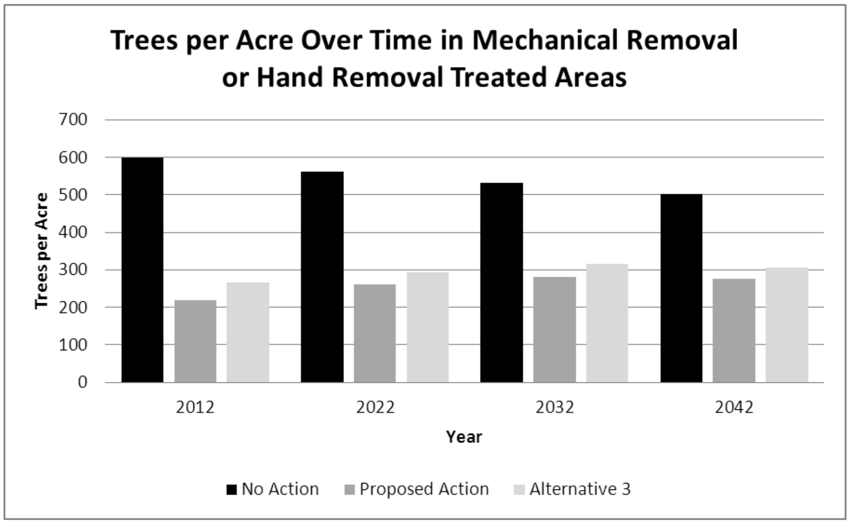

Figure 19. Trees per acre over time for hand and mechanically treated areas for each alternative.

Tree Species Composition

Overall, the effect of treatments from the proposed action, although significant, does not overcome the expansion of fir basal area, the growth of existing trees, or recruitment of new shade-tolerant fir trees. Before treatment in 2012, ponderosa pine occupies 40 percent of the basal area in treated areas; in 2042, ponderosa pine occupies 37 percent of the basal area. Still ponderosa pine occupies five percent more basal area in 2042 under the proposed action than the no action alternative. The modeling also shows in 2042 that shade-tolerant incense-cedar and fir combined occupies approximately five percent less basal area in the proposed action than the no action alternative (32 percent in the proposed action versus 37 percent in the no action). The indirect effect of the proposed action would be a moderate increase in the basal area occupied by ponderosa pine through time, and a moderate decrease in the basal area occupied by incense-cedar and fir through time compared to the no action alternative.

The indirect effect of planting under the proposed action would be that pine would occupy a greater percentage of basal area in the very distant future, assuming that the planted trees survive to maturity.

Large Tree Basal Area

The benefits of larger trees and increase in pine species are indirect benefits achieved later in time. Growing large trees require a period free of stand-replacing events (severe fire and insect attacks). The stand-replacing events kill all trees over dozens to potentially hundreds of contiguous acres.

Currently, stands in the Project area grow under conditions where competition based mortality and density are the primary drivers of future composition. In contrast, studies suggest Sierra Nevada forests historically developed under conditions of trees growing at low density with little competition for water, nutrients and light (Tappeiner et al. 1997, North et al. 2004). These results suggest that tree removal is needed in dense young stands where the management objective is to speed development of old forest characteristics (Tappeiner et al. 1997).

The proposed action's tree removal and prescribed fire treatments provide growing space allowing for tree diameter and crown expansion. Stand density and trees size are inversely related. Trees grown in low-density stands tend to be larger (Oliver and Larson 1996). In addition, research by Poage and Tappeiner (2002) would indicate that open stand conditions might be necessary to grow the large trees that dominated forests under a frequent fire regime. Larger trees are more resistant to the effects of fire.

The indirect effect of the proposed action would provide fewer trees that occupy greater growing space after a period of growth. Tree removal (restoration thinning, ladder fuels thinning, plantation mechanical thinning) maintains sufficient 20 inch to 30 inch size trees to meet immediate wildlife needs and provide for a supply of future large trees (greater than 30 inches DBH). The proposed action retains approximately 95 percent of 20 to 30 inch DBH trees. For more information on the change in basal area for each stand, see the Silviculture Report (Tane 2012). Figure 20 displays the increase in the proportion of large trees over time. The proposed action results in the highest percentage of total basal area occupied by trees greater than 30 inches DBH over time during the 30 year modeling period. The proposed action achieves the greatest proportion of large trees even though the proposed action removes 20 to 30 inch trees and alternative 3 does not. The removal of 20 to 30 inch trees does not lead to a bottle neck or limit meeting the desire for large trees in the future.

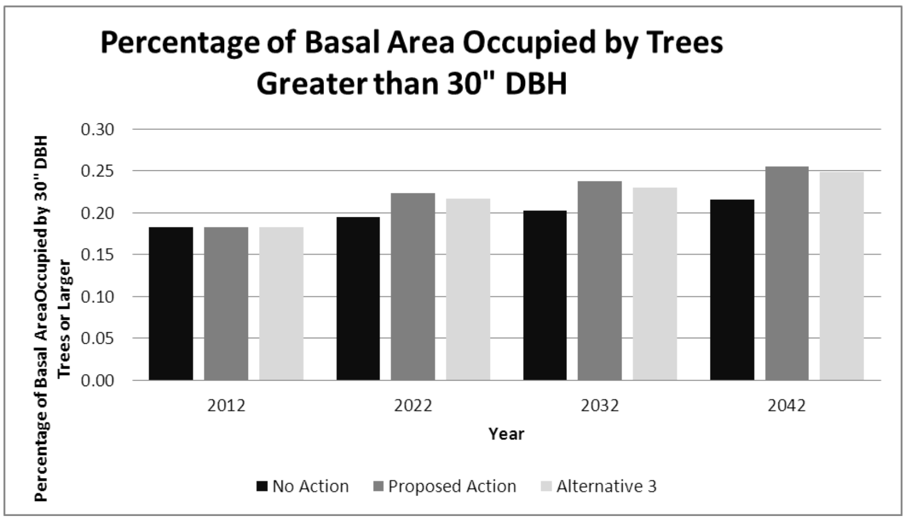

Figure 20. The proportion of basal area occupied by large trees across the Project area for each alternative over a 30 year period.

Snags

The proposed action does not stop snag creation; modeling shows that standing large snag levels at a project level, relative to 2012, are consistently higher through time under the proposed action. However, on a whole, the proposed action creates fewer snags per acre than alternative 3 or the no action alternative. Snag levels are modeled to increase 27 percent between pre-treatment 2012 levels and 2042 under the proposed action. In other words, under the proposed action, more large snags would accumulate in the project area faster than they would fall.

Insect attack causing conifer mortality following fire is known to occur. This is true for both wildfire and prescribed fire. The relationship between fire and insect attack are not clearly understood. Research has most often been done on the interaction of wildfire damage and mortality. Less study has been completed on the relationship between prescribed fire damage and insect mortality (Mitchell and Martin 1980, Parker et al. 2006). Miller and Keen (1960) described the relationship between crown damage from fire and insect mortality. A greater percentage of crown damage results in a greater loss from insect mortality. This relationship between crown damage and attacks by western pine beetle has been described by others (McHugh et al. 2003, Wallin et al. 2003, Breece et al. 2008). Proposed underburns would generally result in crown scorch in high-severity portions of burns. Since crown scorch can lead to insect attack and mortality of pines, the underburn program can indirectly cause snag creation.

In 2022, five years after the controlled burn, there is modeled to be approximately two more large snags per acre in units which had been controlled burned than what would be expected under the no action alternative. This increase in snags is both from the direct and indirect effects of fire. This is roughly in agreement with the scientific literature for the Sierra Nevada's, which found that underburning alone created roughly two more large snags per acre compared to the control (Stephens and Moghaddas, 2005; Innes et al. 2006).

The thinning in the proposed action would decrease the amount of stand density and in turn the amount of density related mortality. This is mainly why the proposed action would create fewer snags than the no action alternative. Mortality levels increase as the effectiveness of the treatment in reducing stand density levels diminishes. However, snag creation levels in the no action alternative are partially a result of human caused activities such as fire suppression and poor air quality (Savage, 1994).

The net indirect effect of the proposed action would be that conditions for more snags in some areas (through the indirect effects of prescribed fire), and conditions for less snags in other areas (areas were mechanical tree thinning and snag removal occurred) would be created. Overall, fewer snags are created than the other two alternatives, but through time the modeled net effect would still be an increase in the number of snags on the landscape.

Stand Density Index

Growth over time increases tree density and SDI across all stands. Increasing tree density results in higher SDI levels and more areas subject to high risk to insect and density induced mortality. Each 10 year modeling period increases the SDI level for the proposed action. This indicates that resilience declines with time after treatment. Still, the indirect effect of the proposed action would be that for the entire 30 year modeling period, the proposed action would keep the number of acres below 60 percent maximum SDI the lowest out of the three alternatives (see **Error! Reference source not found.**Figure 21).

Tree removal results in the creation of logging residue (slash) and can damage individual trees. Slash can also result in the creation of habitat for pine engravers (*Ips* species) when young trees less than eight inches in diameter are thinned. If slash is created between January to June or when slash does not have time to dry, then bark beetles can breed in slash and later emerge to damage or sometimes kill conifers (Furniss and Carolin 1977). Design criteria and forest policy seek to limit the availability of slash for habitat by limiting the time when slash is created. In addition, trees damaged during logging are removed to prevent vectoring disease and insects.

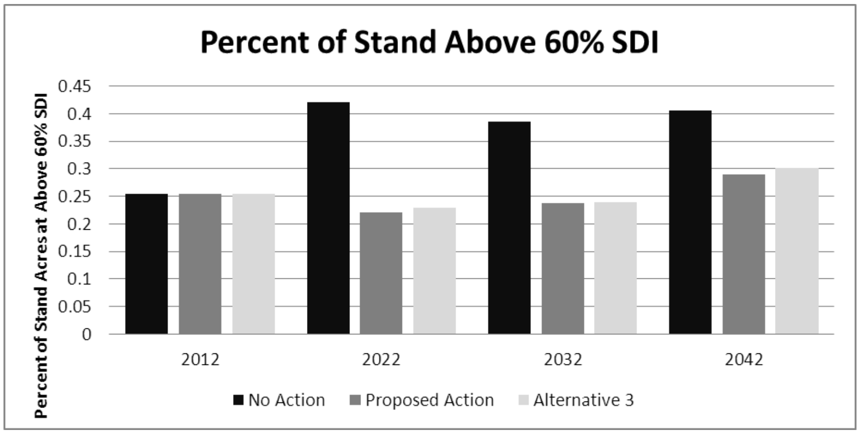

Figure 21. The % of acres above the lower limit of self-thinning (>60 percent) SDI for each alternative.

Controlling Competing Vegetation

Site preparation and release treatments planned for the Project have proven effective in the control of competing vegetation found in openings and plantations. Site preparation, release treatments, and burning would create conditions suitable for the invasion of plants that do well in disturbed sites or open canopies. These plants that arrive following disturbance include grasses (including cheat grass) and other noxious weeds (McDonald and Fiddler 1989, McDonald 1986, Larson and Schubert 1969, and Keeley 2001). While treatments reduce the cover of site competitors, treatments also make conditions for the dominance of sites by conifers (McDonald and Fiddler 1995).

Using site preparation, planting, release (in regeneration openings), and pre-commercial thinning treatments (in existing plantations and regeneration openings), approximately 175 acres of regeneration openings and 38 acres of released existing plantations would be maintained. Regeneration openings and plantations would contain scattered larger trees. These planted seedlings and scattered trees would eventually grow large enough to shade out many of the competing brush and grass species in approximately 15 to 25 years. Reforested montane brush openings would be single storied even-aged stands. Genetic variation would also be reintroduced from seed collections within the local seed zone and growing and planting these conifer and rust-resistant sugar pine seedlings within the Project area. Species composition would be mostly ponderosa pine and some rust-resistant sugar pine and natural regeneration. Natural regeneration would include incense-cedar, white fir, and oaks. Stand development from early brush dominance to conifer dominance would be accelerated over natural stand succession rates.

Conifer growth would be slowed in regeneration openings as a result of both scattered large trees in the openings and adjacent edge trees. Research results indicate that overstory trees tend to suppress the growth of understory seedlings and the more trees remaining resulted in more reduction of growth (McDonald 1976, Birch and Johnson 1992). Edge trees reduce the growth of trees in small group openings. Studies of the growth seedlings in small group openings indicate that trees closer to the edge experience the most reduction in growth (York et al. 2004) and smaller openings tended to reduce height growth of seedlings more than larger openings (McDonald and Abbott 1994). However, large trees from the existing stand along the edge of a group opening may experience increased growth (York, Battles, and Heald 2004). This additional growth may contribute to total stem volume and tree size for a stand, but it is uncertain if this would offset losses from small trees in the regeneration openings.

While scattered overstory trees and edge trees may reduce the growth of planted and natural seedlings, the reduced solar radiation from these trees may benefit the initial establishment of white fir and incense-cedar (Erickson et al. 2005). Other species such as shade-intolerant ponderosa pine may experience lower survival in these shaded conditions (Erickson et al. 2005).

In a dense forest, bear clover is found at low to moderate densities beneath the overstory. Bear clover can fully occupying openings. Overall, bear clover has the greatest amount of brush cover of all species. Ground disturbing activities (e.g. harvest, tractor piling, and mastication) and burning may crush or reduce above ground stems, but the rhizome type root system remains intact and can readily take advantage of increased sunlight and nutrients. A ground application using backpack sprayers of glyphosate and surfactant would reduce the cover of both the above ground and below ground rhizomes. A review of FS experience in non-chemical vegetation control (Click et al. 1988; Click et al. 1994) and local SNF experience indicates that chemical applications are the only effective way to insure reforestation objectives are met.

Research indicates that effective treatments are those that kill bear clover rhizomes, and herbicides such as glyphosate are effective in doing this, while hand, fire and mechanical methods are not effective control treatments (Tappenier and Radosevich 1982, McDonald et al. 2004). In local environments, treatments such as the winged subsoiler[14] and repeated fire at the time of flowering have been suggested for control, but have not proven effective. Fire, hoeing, and machines have been used on the SNF to remove the above ground portion of bear clover; due to the rhizome type root system, sprouting of plants occurred soon after treatment. Sprouts quickly reinvaded these treated areas. Survival of planted seedlings was well below desired stocking levels. Herbicides application has proven the only effective means to control bear clover on the SNF. These results agree with reforestation research that indicates that after three years, only 13 percent of the conifers planted were alive in a study area with bear clover cover of less than 40 percent (Tappenier and Radosevich, 1982). This contrasts with 71 percent survival in areas with temporary control of bear clover. Over a 19-year span, only nine percent of the trees planted in an area with no vegetation control survived. Growth of the surviving seedlings is also impacted. In the same study, three year old seedlings with no bear clover competition were twice as tall as the seedlings with no vegetation control. A review of bear clover control measures by McDonald et al. (2004) also indicate that treatments that kill bear clover rhizomes such as herbicides are the only effective control measure, while other treatments have been failures.

Deer brush and buck brush are the most abundant *Ceanothus* species. *Ceanothus* species in existing openings are well established and have deep root systems. Ground disturbing activities (e.g. underburns, tractor piling, hand cutting and shredding) can stimulate sprouting of *Ceanothus* species. They also create conditions that allow chemical or subsequent hand treatments to be more effective. Treatments that reduce the size of plants also increase the susceptibility of plants to chemical applications by decreasing plant size, disrupting root systems, and reducing the thickness of leaf cuticle allowing for better penetration of chemicals. Mechanical treatments designed to disrupt the root systems of *Ceanothus* make subsequent chemical release treatments effective. Subsequent hand release treatments are then focused on brush seedlings. Experience on the SNF has shown that large plants greater than two feet tall cannot be controlled using hand methods. This is due to the size of the rooting system. *Ceanothus* seedlings have been successfully controlled using hand methods. However, once growth of above ground *Ceanothus* plants exceeds two feet, rooting systems are beyond the effectiveness of hoes or axes used to remove brush seedlings. In addition, the removal of *Ceanothus* results in the dominance of grasses and forbs that also compete for site resources. These same results have been observed in other FS District units where repeated hand release treatments have resulted in limited control of *Ceanothus* seedlings, impractical control of well established (greater than two feet tall) *Ceanothus*, and ineffective control of those that establish from burls or roots (Click et al.1994, McDonald and Fidler 1995).

[14] A tractor with a head capable of ripping soil, generally used to reduce compaction and disturb root systems.

In other studies, ponderosa pine growing in the middle of *Ceanothus* and manzanita had a diameter and height growth of 60 to 90 percent when compared to trees free to grow from competing brush species (Oliver 1979 McDonald and Oliver 1983). In another study, without release from *Ceanothus* brush, conifers are at a disadvantage in capturing adequate resources and establishing dominance. In the control plot (without vegetation management), McDonald and Fiddler (1989) noted that the average height of *Ceanothus* was 184 percent greater than that of conifer seedlings. Though seedlings may persist under a canopy of *Ceanothus*, growth would be very slow. In a study that looked at the release of white fir from *Ceanothus* and green leaf manzanita, white fir survival and height, diameter, and foliar cover growth were all enhanced by early chemical release followed by follow up hand release treatments (McDonald and Fiddler 2001). In a companion study, McDonald and Fiddler (1997b) found that chemical release with follow up hand treatments significantly increased the height and survival of fir over hand treatments or delayed treatments. In another study with green leaf manzanita and *Ceanothus* McDonald and Fiddler (1997) found that ponderosa pine crown cover in the chemical treatment was significantly larger than in the no treatment and mechanical only treatments, increasing by 104 percent over the control and 42 percent over the mechanical treatment alone.

Early medium and heavy cover of *Ceanothus* and green leaf manzanita have long-term effects on conifer growth (McDonald and Abbott 1997). McDonald and Abbott (1997) found that ponderosa pine with moderate brush cover (15 percent cover) five years after establishment and heavy brush cover (21 percent) five years after establishment did not allow planted pine to meet growth standards similar to those in the Project area. In addition, heavy brush pre-disposed ponderosa pine to increased insect attack. In contrast, Oliver and Uzoh (2002) found little diameter and only modest height growth with reductions in understory brush cover under sapling-size fir. Most of the height growth increases occurred in the first five years. Oliver and Uzoh (2002) findings are in contrast to McDonald and Fiddler (1997) results that found a significant difference in survival and height after 10 years between the chemical release treatments and control treatments.

The experience on the SNF controlling *Ceanothus* species has been consistent with published information. In stands on the HSRD, part of the Big Sky timber sale 1992 and Big Creek fire recovery 1994, hand and mechanical means failed to control *Ceanothus*. In the case of the Big Creek fire recovery conifer reestablishment efforts, forest stands were severely burned, salvage logged, planted and hand released. Hand release areas dominated by sprouting *Ceanothus* species had more than 50 percent cover in brush and planted and natural seedlings smaller than adjacent areas without sprouting species. In the case of the Big Sky timber sale treatments, large *Ceanothus* (greater than four feet tall) was cut with chainsaws. Observations in the following year showed *Ceanothus* sprouts to be two and three feet tall.

Ceanothus and manzanita have many morphological and physiological adaptations that allow them to capture resources, growing rapidly after major disturbances. One adaptation is the ability for some *Ceanothus* species to fix nitrogen. While soil nitrogen is beneficial for seedling growth and varies beneath Sierra Nevada vegetation gaps (Erickson et al. 2005), brush cover removes soil moisture needed for seedling survival (Gray et al*.* 2005). Brush cover may benefit the establishment of shade-intolerant species (white fir, incense-cedar and live oak); however the overall benefit for growth of these species was undetermined in the Erickson et al*.* (2005) study in the Teakettle Experimental Forest. Results from the Teakettle Experimental Forest suggest that reductions in shrub cover may benefit tree establishment, but increasing understory light and decreasing surface soil moisture through overstory canopy cover reductions may not.

Green leaf manzanita sprouts from the roots in response to disturbance similar to *Ceanothus*. Manzanita plants in openings and plantations exceed three feet in height. The size of these plants makes hand removal impractical. Manzanita and *Ceanothus* competition was responsible for a 58 percent reduction in growth in a 20 year old Sierra Nevada ponderosa pine stand (Oliver 1990). Once manzanita seedlings begin to grow, they can rapidly occupy a site after disturbance. Ground disturbing activities would affect green leaf manzanita similar to *Ceanothus* species.

The indirect effects of alternative 2 on sprouting brush species would be that site resources would be freed for the growth of conifers.

The single strongest factor affecting planted tree growth in the detailed long-term soil productivity experiment was understory brush cover (Powers et al. 2004). In the Sierra Nevada, where summer drought is common, planted tree productivity averaged more than three times higher in the absence of understory vegetation (Powers et al. 2004). The long history of reforestation on the SNF, research that has examined the growth of conifers with and without brush competition suggest that the indirect effect of alternative 2 on *Ceanothus* and manzanita species would be to free site resources for the growth of conifers. Based on the morphological characteristics that promote sprouting, the history of ineffectiveness of hand control of *Ceanothus* and manzanita, the large body of research that indicates the manzanita and *Ceanothus* are strong competitors with conifers for site resources - herbicides are essential for the control of competing vegetation.

The indirect effect of site preparation and release treatments would be that conditions would be created within regeneration openings and existing plantations that meet the objectives of conifer establishment, survival and accelerated growth in alternative 2.

Cumulative Effects

The cumulative effects spatial and temporal boundary for all the vegetation resource indicators is identical. The Dinkey Landscape conifer zone (approximately 78,000 acres in watersheds adjacent to the Project) is the vegetation cumulative effects spatial boundary (see Appendix C). The temporal boundaries are those actions or potential actions that create changes to the existing condition in the past five years or are reasonably foreseeable.

Canopy Cover and Brush Cover

Across the (78,000 acres) cumulative effects boundary for alternative 2 and current and reasonably foreseeable actions result in a cumulative three percent reduction in acres with tree canopy cover greater than 50 percent. There would also be a corresponding slight increase in general brush cover throughout the acres experiencing increased brush cover.

Trees per Acre

Past, present and reasonably foreseeable projects would or already have reduced the number of trees per acre from within project areas from 400 to 250 trees per acre; the other projects in the cumulative effects boundary would or already have removed approximately 100,000 trees greater than 10 inches DBH from the cumulative effects boundary. Past, present and reasonably foreseeable projects would remove approximately two million trees less than 10 inches DBH. The total population of trees is over 30 million trees.

This removal of trees is balanced by the growth of existing trees and establishment of new trees in the cumulative effects boundary. Likely, in the short to medium run there would be fewer trees of all size classes as a result of management activity. The number of trees would still be far greater than the number of trees per acre consistent with a frequent fire regime forest.

Tree Species Composition and Large Tree Basal Area

Modeled results indicate the current population of trees greater than 30 inches DBH at approximately 470,000. Current and proposed hazard tree, residential development and power line maintenance treatments remove approximately 1,000 trees greater than 30 inches across the 78,000-acre forested landscape. After implementation of alternative 2, proposed and current activities, trees larger than 30 inches DBH would be reduced by less than one half of a percent across the landscape. This is the same for both the proposed action and alternative 3.

Timber harvests on Southern California Edison (SCE) lands would also reduce tree numbers of trees larger than 30 inches DBH. While it is unclear how much these treatments on private lands would reduce large tree numbers, typical prescriptions can remove as much as one third of each tree size class (personal conversation with SCE managers). Mixed conifer forest on federal lands near SCE lands contain approximately six trees per acre larger than 30 inches DBH. A typical 1,000 acre timber harvest off of private lands could remove as much as two trees per acre or about 2,000 trees greater than 30 inches DBH. The cumulative effect of all these treatments would be less than a one percent change in tree numbers greater than 30 inches across the 78,000 acre analysis area.

The cumulative effect of alternative 2, the Dinky South, Dinkey North, East Fork, and KREW projects, and private forest treatments would be an increase in large tree dominance (greater than 35 inches DBH) after 30 years. The indirect cumulative effect at the local scale (4,900 acres) after 50 years would be that a large area with approximately 12 percent more large trees than the no action alternative and about the same as alternative 3. However, these treatments have little direct effect on increasing (less than one percent) large trees over the larger 78,000 acre cumulative effects boundary.

Three to five percent increase in pine species would occur in current, recent past and reasonably foreseeable actions within the project boundaries on approximately 10,500 acres. The exception to this increase is plantation treatments that are already dominated by pine. Increasing pine dominance increases resistance and resilience to severe fire since pine species are more fire resilient in treated areas. However, untreated areas dominated by fir and incense-cedar would continue to accumulate stem area and favor the production of incense-cedar and fir. The growth of incense-cedar and fir across the 78,000 acres would result in cumulative net increases in shade-intolerant fir and incense-cedar dominance.

Snags

Vegetation treatments considered in the cumulative effects analysis within the Dinkey Landscape partially involve removing large trees and large snags (typically hazard trees). Generally, about two hazard trees per acre can be anticipated to be removed from approximately 90 acres (0.05 percent of the cumulative effects boundary). These actions would not reduce the large snags per acre below what is required in the SNF LRMP and due to the scope of large trees removed (approximately two trees per acre over fractional percent of the cumulative effects boundary), the effect on large tree density within the landscape would be minimal, thus having little cumulative effect on large snag recruitment in the future.

Stand Density Index

Approximately 13 percent of the cumulative effects boundary area involves stand thinning projects (KREW, Dinkey North, Dinkey South, East Fork, SCE timber harvest plans, and plantation maintenance projects) that would reduce stand density, increase stand resiliency, and reduce the risk to insect outbreaks within the treatment areas. Alternative 2 would add approximately two percent more acres of thinning treatments or a total cumulative effect of 15 percent.

Across the larger (78,000 acres) landscape approximately one third of the landscape is subject to high risk to insect or density mortality. The result of all present, proposed and reasonably foreseeable actions across the larger landscape is to reduce acres at high risk to insect and density mortality by 2,900 acres. However, tree growth and the resulting increased density across the 78,000 acres results in an overall increase in the area subject to high risk to density induced mortality after only five years. The resulting cumulative effect on density mortality across the larger scale analysis area would be a decrease in the rate at which acres of conifer forest move toward high risk; treatments are small compared to the larger landscape.

Controlling Competing Vegetation

FS thinning projects that are part of the present and future condition typically have a planting in openings component. Projects which are or will be planting in openings include Dinkey North, Dinkey South, KREW, and East Fork. These projects also involve brush control either through chemical or non-chemical methods. In total, 200 to 300 acres of openings would be converted from brush to plantation.

3.2.2.3. Alternative 3

Direct Effects

Canopy Cover and Brush Cover

Maintaining canopy cover over 50 percent is used to compare effects on vegetation between alternatives. Changes in canopy cover resulting from mechanical and hand treatments are addressed in this section.

In 2012 of the 53 stands currently above 50 percent canopy cover, alternative 3 would reduce the canopy cover below 50 percent in four stands, compared to 10 stands in the proposed action. Mechanical treatments drop the average canopy cover across treated areas from 61 percent to 56 percent, slightly greater average canopy cover than 55 percent created by the proposed action. Similar to the proposed action, no stands above 40 percent canopy cover would drop below 40 percent canopy cover as a result of alternative 3. No stands above 50 percent canopy cover would drop below 50 percent canopy cover in spotted owl PACS. Once all treatments are completed approximately 3,504 acres are maintained over 50 percent canopy cover in alternative 3, compared to 3,207 acres under the proposed action. Overall, the direct effect of alternative 3 would be that the second most acres above 50 percent canopy cover would be maintained out of the three alternatives.

Outside of areas which would be planted in the proposed action, all activities which have direct effects on brush (tractor pilings, mastication, grapple piling, hand cutting and underburning) would be the same between the proposed action and alternative 3. Therefore, the direct effect on brush (outside of planting areas) would be the same for alternative 3 and the proposed action.

Trees per Acre

Table 12 below summarizes the removals for alternative 3.

Table 12. Tree figures across all treated stands (including stands receiving prescribed fire only) for alternative 3.

Alternative 3 (thousands of trees)						Average Trees per Acre			
DBH Class	0" to 10"	10" to 20"	20" to 30"	over 30"	Total	under 10"	10 to 20	20 to 30	over 30
Existing trees	2243.2	225.1	51.7	16.4	2536.5	414.7	41.6	9.6	3.0
Mechanical Tree Removals	653.6	2.2	0.0	0.0	655.8	120.8	0.4	0.0	0.0
Percent removal	29%	1%	0%	0%	26%				
Percent remaining	71%	99%	100%	100%	74%				

Immediately after stands would be treated mechanically or by hand in alternative 3, but before underburns in 2017 are simulated, there are approximately 348 trees per acre on the average (compared to 333 in the proposed action). In year 2022, there are 324 trees per acre. This is 10 more trees per acre than the proposed action for 2022. The reduction in trees per acre is especially pronounced when focused on the 1,605 acres treated with hand or mechanical tree removal. In these areas, in 2012, stand density drops from 600 trees per acres to 334 trees per acre under alternative 3. This is 116 trees per acre more than the proposed action.

Trees per acre levels above 10 inches DBH remain relatively unchanged compared to the proposed action which removes 2.8 trees per acre above 10 inches DBH, alternative 3 only remove 0.4 trees per acre above 10 inches DBH.

Existing openings would not be reforested under this alternative. Conifer establishment and thinning combined under alternative 3 would result in fewer trees generally, but to some degree there would be additional trees of desirable species in openings, changing tree numbers in the area of openings. Growth of conifers that would occur in these small openings or adjacent to openings would increase (McDonald and Reynolds 1999) but would be dependent on site factors.

The direct effect of alternative 3 would be that the second most trees per acre would be removed out of the three alternatives.

Tree Species Composition

Alternative 3 like the proposed action targets removal of shade-tolerant species over pine. However, since fewer trees from smaller size classes would be removed, the effect of this removal/retention priority would not have as great of an effect on the reduction of shade-tolerant tree species as the proposed action. Prescribed fire would have an identical effect between the proposed action and alternative 3, both selectively killing small incense-cedar and fir. Unlike the proposed action, alternative 3 would not plant trees.

In the year 2022, 43 percent of the basal area would be occupied by ponderosa pine compared to 44 percent under the proposed action and 42 percent in the no action alternative. This increase (relative to the no action alternative) is due to the growth of existing ponderosa pine and removal of incense-cedar and white fir. Incense-cedar and white fir occupies a combined 28 percent of the basal area in the proposed action and alternative 3, compared to a combined 30 percent under the no action alternative. Therefore the direct effect of alternative 3 would be a very moderate increase in the basal area occupied by pine and a very moderate decrease in the amount of incense-cedar and white fir compared to the no action alternative, but wouldn’t increase the basal area occupied by pine as much as the proposed action.

Large Tree Basal Area

By removing small tree basal area, the percentage of basal area occupied by larger trees increases (since the large tree basal area remains unchanged but the total basal area decreases). In 2022, the first year after all treatments are completed that is modeled, 21.3 percent of the basal area is occupied by large trees (trees greater than 30 inches DBH) under alternative 3, compared to 22.4 percent under the proposed action and 19.4 percent in the no action alternative. The direct effect of the alternative 3 would be a moderate shift in the basal area to large trees when compared to the no action alternative, but not as much as the proposed action.

Snags

The direct effect of alternative 3 on snags in some respects is similar to the proposed action. Prescribed fire would create some large snags and may remove other large snags. Hazard tree removal would remove some large snags which are hazards to improvements. Unlike the proposed action, alternative 3 would not remove snags between 12 and 30 inches DBH unless they are hazards.

Stand Density Index

The direct effects of alternative 3 on SDI would be that trees would be removed or killed thus reducing the number of acres above the high density mortality threshold. The alternative would not eliminate the potential for insect attack or disease. In 2022 (the soonest year after treatment that SDI modeling is available), under alternative 3, approximately 29 percent of the acres within treated stands would continue to have high insect and mortality risk, compared to 22 percent for the proposed action and 42 percent for the no action alternative. If one looks only at those stands which receive mechanical treatment, the contrast becomes even starker, with 21 percent of the acres being at high risk for insect mortality under the alternative 3, compared to 12 percent for the proposed action and 45 percent for the same acres under the no action alternative. Alternative 3 has the second least amount of acres at high risk for insect attack.

Controlling Competing Vegetation

Treatments in alternative 3 would have direct effects that create conditions more favorable to seedling establishment. Tractor piling, grapple piling, and prescribed fire create areas of bare mineral soil which would be favorable towards the establishment of pine. However, treatments do not remove the root system of sprouting plants which are competitive with seedlings. Pine trees may establish in openings, but within two to three years they would be in strong competition with brush that would negatively affect seedling growth and survival.

Indirect Effects

Canopy Cover and Brush Cover

Indirect effects on canopy cover are those that occur as a result of growth or mortality following proposed treatments. Alternative 3 would reduce canopy cover on several hundred acres. This reduction is the result of both tree removal treatments and underburning. However, trees that remain following tree removal reoccupy growing space and increase canopy cover with time.

Acres of canopy cover over 50 percent increases over the 30-year analysis period following thinning in all action alternatives. After 30 years, alternative 3 produces approximately 3,491 acres with a canopy cover over 50 percent. This is approximately 284 acres more than what is produced under alternative 2 and approximately 1,036 acres less than the no action at the end of the 30 year analysis period. The indirect effect of alternative 3 would be that the second most acres over 50 percent canopy cover would be produced out of the three alternatives.

At a Project level, alternative 3 would create conditions with only a slightly greater canopy cover than the proposed action. Brush cover and volume would generally increase in response to more open canopy conditions just as what would occur in the proposed action. However, in areas which would have greater canopy cover than the proposed action, brush cover would expand to a lesser degree than what would occur in the proposed action.

Trees per Acre

Figure 19 above shows the trends of trees per acre for all size classes over time in areas hand or mechanically thinned. Modeling for 1,605 acres of thinning, shows that in 2042, the trees per acre under the alternative 3 would increase to 306 trees per acre without further treatment. This is 31 trees per acre more than the proposed action. Interestingly, between 2032 and 2042, the amount of trees per acre actually declines from 316 to 306. This is likely because ingrowth of new trees is out paced by mortality, most likely driven by bark beetles.

The indirect effect of alternative 3 would be that the alternative would have the second most trees per acre of the three alternatives.

Tree Species Composition

Overall, the effect of treatment in 2012 would not overcome the expansion of fir basal area, the growth of existing trees and recruitment of new shade-tolerant fir trees. Before treatment in 2012 ponderosa pine occupies 40 percent of the basal area in treated areas, in 2042 ponderosa pine occupies 36.7 percent of the basal area under alternative 3. The percentage of pine basal area occupied under alternative 3 is slightly less than the 37.5 percent of basal area occupied by pine under the proposed action. The modeling also shows in 2042 that shade-tolerant incense-cedar and fir occupy approximately one percent more basal area in alternative 3 compared to the proposed action 32 percent to 33 percent. The indirect effect of alterative 3 would be more basal area occupied by pine through time when compared to the no action alternative, but slightly less basal area occupied by pine when compared to the proposed action.

Large Tree Basal Area

The benefits of larger trees and increase in pine species are indirect benefits achieved later in time. Growing large trees require a period free of stand-replacing events. These stand-replacing (severe fire and insect attacks) events kill all trees (larger and small) over dozens to potential hundreds of contiguous acres.

The indirect effect of alternative 3 would provide fewer trees that occupy greater growing space after a period of growth. However, alternative 3 would only remove trees up to 12 inches DBH. Generally, the larger the tree the more resources the tree needs and competes with other trees to obtain. Since only trees 12 inches DBH and smaller are removed, tree thinning under alternative 3 would have only a moderate effect of reducing completion between trees. Trees retained under alternative 3, in particular large trees, would not grow as fast as under the proposed action. The Silviculture Report (Tane 2012) contains information on the change of basal area for each stand. From Figure 20 it is clear that the indirect effect of alternative 3 would be a slightly smaller percentage of basal area occupied by large trees than the proposed action, but a greater percentage than the no action alternative through time.

Snags

With regards to hazard tree removal and prescribed fire, the indirect effects of alternative 3 would be identical to the proposed action. The difference between the indirect effects of the proposed action and the indirect effects of alternative 3 is that alternative 3 would not reduce the density and competition to the degree that the proposed action would. Therefore under alternative 3, more large trees would die through time because of the growing conditions created by this alternative. More large snags could result in further hazard trees, requiring more future hazard tree reduction treatments when compared to the proposed action.

Snags over 15 inches DBH would remain on the landscape under alternative 3 (unless they are hazards). This effect would last for an uncertain number of years, likely a maximum of five to 15 years until those snags which would have been cut down under the proposed action fell anyway.

Modeling indicates that alternative 3 would create approximately 10 percent more snags through time than the proposed action. Alternative 3 is modeled to increase the number of standing large snags by 37 percent between 2012 and 2042, whereas the proposed action is modeled to increase the amount of snags by 27 percent. The no action alternative, which keeps density levels at present conditions, would create 58 percent more large snags from 2012 to 2042. The indirect effect of alternative 3 would create the second most snags of the three alternatives. The action alternatives are modeled to create more snags than present conditions.

Stand Density Index

Growth over time increases tree density and SDI across all stands. Increasing tree density results in higher SDI levels and more areas subject to high risk to insect and density induced mortality. Each 10 year modeling period the SDI level increases for alternative 3. This indicates that resilience lessens with time after treatment. Still, the indirect effect of alternative 3 would be slightly more acres at high risk for insect mortality in this alternative when compared to the proposed action but far less than the no action alternative (see Figure 21).

Tree removal under alternative 3 would have the same effect of damaging trees not targeted for removal as the proposed action. Since only small trees would be removed under alternative 3, fewer trees would likely be damaged. However, in stands where post-logging fuels are being treated with tractor piling, far more trees would be damaged due to tighter spacing.

Controlling Competing Vegetation

Alternative 3 has no release treatments, therefore as already analyzed in the direct effects section, brush would quickly re-occupy the site, and in most situations would out-compete seedlings. Therefore, openings are unlikely to be substantially different from the no action alternative in the long run with regards to indirect effects on brush openings.

Cumulative Effects

The cumulative effects for many of the vegetation indicators are additive, so the only difference between the cumulative effects of the proposed action and alternative 3 is the sum of the difference between the direct and indirect effects. Therefore cumulative effects for canopy cover and brush cover, trees per acre removed and retained, basal area of pine species, basal area occupied by large trees, and snags have already been analyzed through the cumulative effects of the proposed action and the direct and indirect effects of alternatives 3.

Stand Density Index

Since alternative 3 leaves a slightly higher amount of SDI in the stand than the proposed action, the chance that the already high levels of insect mortality in the Project area would continue to increase are moderately higher. If bark beetles reach epidemic levels, they could attack adjacent areas within the landscape that would otherwise not be affected by bark beetles. Since the difference in acres above 60 percent SDI are moderate between the proposed action and alternative 3, the difference in cumulative effect between the two alternatives is also moderate.

3.3. Terrestrial Wildlife[15]

3.3.1. Background and Affected Environment

One of the focuses of the terrestrial wildlife analysis is to address the effectiveness of the alternatives in meeting the purpose and need to protect terrestrial wildlife species and to protect and enhance their potential and suitable habitat within the Project area. The analysis also addresses concerns/recommendations brought up during scoping related to providing greater emphasis on the protection of FSS species, Pacific fisher and California spotted owl and habitat for both species.

3.3.1.1. California Spotted Owl

The California spotted owl is designated by the Regional Forester as a FSS species and is selected as a MIS on the SNF. The SNF has 234 designated California spotted owl PACs and 228 HRCAs. PACs are delineated around spotted owl territorial pairs or territorial individuals and are compromised of the best available habitat encompassing 300 acres. The SNF LRMP provides direction to designate PACs and HRCAs compromised of the best habitat using California Wildlife Habitat Relationships (CWHR) types 6, 5D, 5M, 4D, and 4M. These CWHR types are in essence considered suitable habitat (nesting and foraging) for California spotted owls. Pure eastside pine types are not considered suitable for California spotted owls. Currently, there are 3,556 acres of suitable spotted owl habitat with CWHR types 6, 5D, 5M, 4D, and 4M within the analysis area.

The SNF has conducted surveys for spotted owl presence and reproductive status across the forest since the early 1980s. Approximately 200,000 acres of suitable habitat, which includes 3D and 3M habitat types, has been surveyed on the SNF following Pacific Southwest Region (R5) FS Protocol.

The U.S. Fish and Wildlife Service (USFWS) (U.S. Dept. of Interior 2006) issued its 12-month finding on a petition to list the California spotted owl as T&E. In its finding, published on May 24, 2006, the USFWS found that the petitioned action was not warranted. The USFWS went on to conclude that the scale, magnitude, or intensity of effects on the California spotted owl resulting from fire, fuels treatments, timber harvest, and other activities did not rise above the threshold necessitating protection of the species under the Endangered Species Act. Therefore, the California spotted owl’s status remains unchanged. The California spotted owl is neither listed under the federal Endangered Species Act, nor currently is it a candidate for listing.

Habitat and Habitat Suitability

California spotted owls use or select habitats for nesting, roosting, or foraging that have structural components of old forests, including large-diameter trees, high tree density, multi-layered canopy/complex structure, and high canopy cover (Laymon 1988, Bias and Gutierrez 1992, LaHaye et al. 1992, Gutierrez et al. 1992, Zabel et al. 1992). About 80 percent of known sites are found in mixed-conifer forest.

Gutierrez et al. (1992) found that spotted owls preferentially use areas with at least 70 percent canopy cover, use habitats with 40 to 69 percent canopy cover in proportion to their availability, and spend less time in areas with less than 40 percent canopy cover than expected if habitat were selected randomly. California spotted owls in the Sierra Nevada prefer stands with significantly greater canopy cover, total live-tree basal area, basal area of hardwoods and conifers, and snag basal area for nesting

[15] The terrestrial wildlife section is a summary of the Terrestrial Wildlife BA/BE and MIS reports prepared for the Soaproot Restoration Project. These reports are herein incorporated by reference and are available in the Project planning record located at the HSRD office.

and roosting. Stands suitable for nesting and roosting have: (1) Two or more canopy layers; (2) dominant and co-dominant trees in the canopy averaging at least 24 inches dbh; (3) at least 70 percent total canopy cover (including the hardwood component); (4) higher than average levels of very large, old trees; and (5) higher-than-average levels of snags and downed woody material (Gutierrez et al. 1992).

Spotted owl pairs have large home ranges that may overlap those of other spotted owls (Verner et al. 1992b). Estimates of California spotted owl home-range size are extremely variable. All available data indicate that they are smallest in habitats at relatively low elevations that are dominated by hardwoods, intermediate in size in conifer forests in the central Sierra Nevada, and largest in the true fir forests in the northern Sierra Nevada (Zabel et al. 1992, USFS 2001). Based on an analysis of data from radio telemetry studies of California spotted owls, mean home-range sizes of breeding season pairs were estimated at 3,642 hectares (ha) (9,000 acres) in true fir forests on the Lassen NF, 1,902 ha (4,700 acres) in mixed conifer forests on the Tahoe and Eldorado NFs, and 1,012 ha (2,500 acres) in mixed conifer forests on the SNF (USFS 2001).

Nesting Habitat

Verner et al (1992) reported that micro-habitats used for nesting typically have greater than 70 percent total canopy cover (all canopy above 7 feet), except at very high elevations where canopy cover as low as 30 to 40 percent may occur (as in some red fir stands of the Sierra Nevada). Nest stands typically exhibit a mixture of tree sizes and usually at least two canopy layers, and some very large, old trees are usually present. Often these have large, natural cavities, broken tops, and/or dwarf mistletoe brooms. Nest stands in conifer forests usually have some large snags and an accumulation of fallen logs and limbs on the ground; downed woody debris is not a major component of nest sites in lower-elevation riparian/hardwood forests. Spotted owls do not build their own nests but depend mainly on finding a suitable, naturally occurring site. Nest heights vary regionally, about 38 feet in riparian/hardwood forests at lower elevations, and about 65 and 57 feet in conifer forests of the northern and southern Sierra Nevada. In Sierra conifer forests, nests are usually in cavities or on broken-topped trees or snags. Less often they are on platforms associated with abandoned raptor nests, squirrel nests, dwarf mistletoe brooms, or debris accumulations in trees. Cavity nests dominate nest types of California spotted owls in the Sierra Nevada. Nest trees are typically large (dbh of about 45 inches) for nest trees in Sierra conifer forests and decadent. Some owl pairs use the same nest cavity or platform repeatedly from year to year, some select new sites each year, and yet other alternate nest sites over time (Forsman et al. 1984).

Roosting Habitat

Verner et al (1992) found that stands used for roosting are similar to those used for nesting, with relatively high canopy cover, dominated by older trees with large diameters, and with at least two canopy layers. Studies of roosting northern spotted owls indicate that they respond to variation in temperature and exposure by moving higher or lower within the canopy, or around the roost tree, to access more comfortable microclimates (Forsman et al. 1984). The structure of multi-storied stands characteristic of roost sites facilitates this movement.

Occurrence in the Project Area

There are six California spotted owl PACs and/or HRCAs within (Fresno County [FRE]018, FRE0119, FRE0121, FRE0147, FRE0167, FRE0168, FRE0191) or adjacent (FRE0147, FRE0165, FRE0166) to the Project area. Table 13 below shows the history of the PACs/HRCAs for the last five years (Sutton, pers. comm. 2011). The owls within the Project area are surveyed by USFS Pacific Southwest Research Station (PSW). The total Project area is 6,958 acres; 3,442 is not suitable spotted owl habitat. There are approximately 3,556 acres (51 percent of Project area) of suitable spotted owl nesting (1,619 acres) and foraging habitat (1,937 acres) within the Project area.

Table 13. Status of California spotted owl PACs and HRCAs within or adjacent to the Project area.

PAC	2007	2008	2009	2010	2011
FRE018	Reproduction – 1 young	Pair – Non reproducing	Reproduction – 1 young	Reproduction – 2 young	Female detected later moved
FRE0119	No birds	No birds	No birds	Single bird	No birds
FRE0121	Pair – Non reproducing	Pair – Non reproducing	Reproducing – 1 young	Pair - Non-reproducing	Pair – Non reproducing
FRE0147*	Reproduction – 1 young	Pair – Non reproducing	Pair – Non reproducing	Pair – Non reproducing	Pair – Non reproducing
FRE0165*	No information	No information	No information	No information	No information
FRE0166*	No information	Pair – Non reproducing	Pair	Pair – Non reproducing	No information
FRE0167	No birds	No birds	No birds	No birds	No birds
FRE0168	No birds	No birds	No birds	No birds	No birds
FRE0191	No birds	No information	No information	No information	No information

*PACs adjacent to Project boundary

3.3.1.2. Pacific fisher

The Pacific fisher is designated by the Regional Forester as a FSS species and is the only existing species of the fisher. The Center for Biological Diversity (CBD) submitted a petition on January 23, 2008, seeking action by the Fish and Game Commission (Commission) to list the Pacific fisher as a T or E species under the California Endangered Species Act ("CESA"; Fish and Game Code (FGC) §2050-2116). Pursuant to § 2073 of the FGC, on January 31, 2008, the Commission transmitted the petition (CBD 2008) to the CDFG for review. On March 4, 2009, the Commission voided and set aside its August 7, 2008 decision rejecting the petition, and voted to accept the petition to list the fisher as a T or E species. A Notice of Findings was published in the California Regulatory Notice Register on April 24, 2009, designating the fisher a candidate species, thereby starting the candidacy period and the one year status review process.

On April 8, 2004, in a 12-month finding for a petition to list the west coast distinct population segment of the fisher, the USFWS added the fisher to the list of candidate species. The USFWS concluded that the Pacific fisher is a "species" as defined by the Endangered Species Act (USFWS 2004).

Southern Sierra Fisher Conservation Area

The southern Sierra Nevada provides habitat for the southernmost population of fishers. The small and isolated southern Sierra fisher population has persisted for many decades (Spencer et al. 2008). Some evidence of population expansion has been indicated as a result of systematic monitoring since the 1990's (Truex pers. comm.).

The SSFCA is 720,609 acres across the SNF or 1,108 square miles in size. It ranges in elevation from 3500 feet to 8000 feet. There are 5,496 acres of the SSFCA in the Project boundary; 3,556 acres of which are suitable habitat. The portion of SSFCA suitable habitat in the analysis area is 65 percent.

Model Predicting Probability of Fishers

In 2007, the Conservation Biology Institute (CBI) developed a model predicting the probability of fishers occurring in areas of the southern Sierras (Spencer et al. 2007a). There are 6,998 acres that are within the Project boundary. As seen in Table 14, the majority (75 percent) is within the lowest probability for fisher.

Table 14. Predicted probability of occupancy by fisher.

Probability of Predicting fisher occupancy	Acres
0-19%	4914
20-39%	726
40-59%	565
60-79%	467
80-100%	326
Total	**6998**

The well-studied Kings River Fisher Project (KRFP) area is centrally located within the southern Sierra on the SNF. Fishers have been studied and monitored within the KRP area since the mid-1990's (Mazzoni 2002, Zielinski et al. 1997, Rick Truex 2005, Truex pers. comm. 2006, Jordan 2007). More recently, Kathryn Purcell and Craig Thompson from PSW have initiated a research project on fishers in and around the KRP area (Thompson et al. 2009). Utilizing a combination of radio collared individuals, fisher scat detecting dogs and remote cameras, they have captured and collared a total of 49 fishers (20 males and 29 females), have adequate data (≥ 25 locations) to delineate home ranges for 31 individuals (9 males and 22 females), and located a total of 47 structures used as dens by reproductive female fishers (n = 14), including 18 natal dens, 28 maternal dens, and 1 unknown den (found late in the denning season) as of August 2009 .

The Sierra Nevada Adaptive Management Project (http://snamp.cnr.berkeley.edu/) is also conducting an intensive investigation into fisher use of habitat and response to management disturbance, largely within the SNF.

An additional small PSW research project, utilizing GPS collars to document the immediate response of fishers to fuel treatment actions throughout the southern Sierras is currently occurring on the Sequoia NF.

A number of southern Sierra Nevada population estimates and simulations have been conducted, with results converging as presented in Table 15 below.

Table 15. Estimates of southern Sierra Nevada fisher population occurring across the Sequoia NF and SNF, Mountain Home State Park, tribal lands, Yosemite and Sequoia-Kings Canyon National Parks.

Study or Researcher	Estimate of So. Sierra ADULT Population	Number of Reproductive Adult Females (Ne)
Lamberson et al. (2000)	100 - 500	Not Estimated
Spencer et al. (2008) = CBI	160 - 360	50 - 120
Spencer et al. (2008) based on Jordan (2007).	276 - 359	55 - 83
From Spencer et al. (2008) based on Truex (2007) from Southern Sierra Nevada Monitoring (sampling theory extrapolation)	160 - 250	Not Estimated
Self et al. (2008)	548 - 598	Not Estimated

Further details on the table listed above can be found in the BE report for terrestrial wildlife located in the Project record.

Habitat and Habitat Suitability

Habitat is largely restricted to a narrow north-south band on mostly western slopes of mid-elevation forests in the southern Sierra Nevada Mountains (Spencer et al. 2008). It is associated with mesic topographic positions (northern slopes) in areas of lower precipitation (less persistent snow cover), and is concentrated in or near large old stands of mixed conifer, sequoia, and ponderosa pine, especially areas with black oak (Spencer et al. 2008). An analysis of Forest Inventory and Analysis (FIA) plot data from suitable habitats demonstrated that highly suitable resting microhabitats in the form of clusters of very large trees surrounded by dense canopy are relatively rare (Spencer et al. 2008).

Mazzoni (2002) studied habitat use by fishers in the Kings' River Experimental Watershed (southern Sierra Nevada). Ninety percent of fisher rest sites were in large live trees (mean dbh = 37in) and large snags (mean dbh = 40in). Large logs as well as stumps and rock crevices were also used for resting. Selection for resting in white fir, ponderosa pine and black oak was evident, and selection against incense-cedar and sugar pine was documented. Compared to random sites, areas of 2.47 acres surrounding rest sites had greater levels of canopy, coarse woody debris, basal area, crown volume and canopy layering. Rest sites were closer to water than random sites, and Mazzoni (2002) suggests this may be an artifact of riparian buffers that retain large structural elements of the habitat and dense canopy. The importance of ecological processes such as decay and disease, especially mistletoe brooms, are highlighted for creating fisher rest structures. This has also been documented in other portions of the fisher's range (Paragi et al. 1996, Parks et al. 1999).

Zielinski et al. (2004) found that female rest sites, when compared to random sites, included denser canopies, larger trees, steeper slopes, and greater presence of large conifer snags.

Den Sites Selection

It is important to review data most localized to the analysis area because that best reflects availability and use of habitat elements in the specific geographic vicinity being analyzed. Where such data are lacking, expanding the data universe to include the nearest information is an accepted scientific practice. Due to ecological differences, separation of data for conifer and hardwood den trees is recommended (Truex, pers. comm.). Natal dens refer to the site where parturition is assumed to have occurred, while maternal dens refer to sites where an adult female was observed resting with one or more kit(s) (Purcell and Thompson, pers. comm).

Table 16. Natal and maternal den means for female fishers in KRP area of SNF through 2009.

Den type	Substrate	Mean DBH (in)	N
Natal	Live conifer	44.3	9
	Live hardwood	35.8	8
	Snag conifer	31.7	1
	Snag hardwood	28.0	1
Maternal	Live conifer	39.6	7
	Live hardwood	30.0	14
	Snag conifer	39.6	12
	Snag hardwood	--	0

Den tree data collected in KRP area on the SNF in 2008 and 2009 (see Table 16 above and Table 17 below) (Purcell, pers. comm.) included use of black oak, white fir, incense cedar, ponderosa pine, and sugar pine. Oaks selected as den sites averaged 31.9 inches dbh and conifers averaged 40.7 inches dbh.

Twenty-three of 52 dens (44 percent) were in black oaks, which do not typically leaf out until mid–late May, thus providing little canopy cover during actual use periods. Selection of these sites may be driven by their location and associated access to warming morning sun (Purcell and Thompson, pers. comm.). All confirmed births through the 2008 field season occurred between March 30th and April 11th, and natal dens were occupied for two to eight weeks.

In 2007 and 2008, den sites in the KRP area occurred in Sierran mixed conifer, montane hardwood-conifer and ponderosa pine forest types (Purcell, pers. comm.). Black oak was strongly selected as the den tree (Thompson pers. comm.). On the KRP study area, natal dens (n=7) averaged 46 feet high with a range of six to 110 feet (Purcell, pers. comm.). Maternal dens (n=7) on the KRP averaged 21.6 feet high, with a range of nine to 41 feet (Purcell, pers. comm.). Generally, natal dens were found to be larger than maternal dens, only 1 hardwood snag was used, and conifer snags appear to be used more as maternal dens (Purcell and Thompson, pers. comm.). As of 2009, average canopy cover was 74.3 percent (SD = 12.4, range 47.5 – 99.0, n = 51). Moosehorn readings at 2, 5, 10, and 15 meters, in four directions were averaged to measure canopy cover (Purcell and Thompson, pers. comm.).

Table 17. Summary of denning and resting structures used by fishers in the Kings River area of the SNF from 2007 to 2010 (USDA 2010).

Tree Species	Natal Dens	Maternal Dens	Resting
Black Oak (live)	12	32	78
Black Oak (snag)	2[1]	0	10
White fir (live)	6	6	51
White fir (snag)	4	8	63 (+ 1 log)
Incense-Cedar (live)	4	4	25
Incense-Cedar (snag)	1	6[2] (+ 1 log)	12 (+ 1 log)
Sugar Pine (live)	0	0	15
Sugar Pine (snag)	0	4	8 (+ 1 log)
Ponderosa Pine (live)	1	2	29
Ponderosa Pine (snag)	0	0	13 (+ 1 log)
Total	30	63	319

1 one of these structures was used twice by different females

2 one structure used twice by the same female

Other species used as rest sites include alder (1), giant Sequoia (1), hazel (1), Jeffrey pine (5), and Red fir (1).

Rest Site Selection

Large diameter black oaks and canyon live oaks compose almost half of the rest sites used by fishers in the southern Sierra Nevada (Zielinski et al. 2004a). From 2007 to 2008, rest sites of all trees in the KRP area have averaged 35.8 inches DBH, ranging from 9.4 to 73.5 inches (n = 152; Thompson, pers. comm.).

Table 18. Mean values for fisher rest trees and snags in the SNF from 1999 to 2001 (derived from Table 1 in Purcell et al. 2009).

Tree Type & Fisher Gender	Dbh (inches)			Height (feet)		
	n	Mean	SD	n	Mean	SD
All Live	57	37.5	11.5	49	120.3	39.4
Females	47	38.5	11.9	39	122.2	39.3
Males	10	32.8	8.0	10	113.0	40.9
Conifers Only	49	37.2	12.2	342	130.5	32.6

Tree Type &	Dbh (inches)			Height (feet)		
Females	40	38.4	12.7	33	134.0	29.9
Males	9	32.0	8.2	9	117.5	40.6
Snags	12	46.0	18.6	11	55.6	47.3
Females	6	38.9	12.6	6	49.1	39.7
Males	6	53.0	22.0	5	63.4	59.1

Most resting structures used in the KRP area were in live trees (76 percent), 15 percent were in snags, three were in logs and two each were in stumps and rock crevices (Table 18) (Purcell et al. In Press). Mean canopy cover as measured by moosehorn at rest sites was 73.7 percent, compared to random site canopy cover of 55.3 percent (Purcell et al. 2009).

Estimated Number of Rest and Den Trees Required for Fishers in Each Home Range

A review of available literature and anecdotal information was used to develop an estimate of forest structure used by a given fisher during their lifetime. Obviously, these numbers are somewhat speculative, but this provides what we consider to be a minimum number of resting structures that need to be available to fishers post-project. Given that fishers generally use at least one rest site per day, and have been reported to reuse only about 14 percent (range of 3 - 27 percent) of rest site structures (Seglund 1995, Self and Kerns 2001, Mazzoni 2002, Zielinski et al. 2004a, Yeager 2005, Aubry and Raley 2006), this equates to a minimum of 314 rest trees needed per an average southern Sierra Nevada female home range (2,357 acres) annually. The large range of three to 27 percent appears to be an artifact of divergent assumptions made in data analysis, with the larger numbers being reflective of number of incidents of reuse (counting multiple uses of a given tree as separate instances of reuse even by the same individual), while the lower numbers are the number of individual trees actually used more than once. In the future, we hope to reanalyze the data to a common definition of "reuse". For Project analysis purposes, the most useful number reflects the number of individual trees reused.

Home Range Composition

On the SNF, Mazzoni (2002) found home range composition by canopy closure class for males and females combined (n = 11), to be dense on 14 percent of the home range, moderate on 39 percent, open on 25 percent, and sparse (canopy closure less than 25 percent) on 21 percent of the home range area. These results differ substantially from those reported from the Sequoia NF in Table 19 below.

Table 19. Female fisher CWHR type home range composition on the Sequoia NF (n=8), derived from Zielinski et al. (2004). based on 100% minimum convex polygons.

CWHR System Type	Mean Home Range Percentage	Standard Deviation
Forest Type		
Sierran Mixed Conifer	39	29
Ponderosa Pine	40	27
Montane Hardwood	14	15
Montane Hardwood-Conifer	6	4
Mixed Chaparral	0.2	0.4
TOTAL OF HOME RANGE 1	99	---------
Size Class		
4: small tree 11" – 24" dbh	61	21
3: pole tree 6" – 11" dbh	22	28
5: med/large tree > 24" dbh	13	13
2: sapling tree 1" – 6" dbh	2	2

CWHR System Type	Mean Home Range Percentage	Standard Deviation
TOTAL OF HOME RANGE 2	98	---------
Canopy Closure		
Dense 60 – 100 %	72	9
Moderate 40 – 59 %	20	7
Open 25 – 39 %	5	3
TOTAL OF HOME RANGE 3	97	---------

Occurrence in the Project Area

On the HSRD, the fisher den site buffers have been delineated for 21 sites. At this time, of the 21 sites, four (F12, F16, F22 and F24) are within/adjacent to the Project boundary and eight (F04, F05, F13, F14, F19, F21, F27 and F28) are within the 3.1 mile buffer that is analyzed in this document. To date, there are 2,099 acres of fisher den buffers that are designated within the Project boundary (32 percent of the Project area). There are 9,133 acres that are designated for fisher den buffers (16 percent of the buffered area) within the 3.1 mile buffered area (57,095 acres). The den site buffers were based on the designation description from the SNFPA 2004 which states “fisher den sites are 700-acre buffers consisting of the highest quality habitat (CWHR size class 4 or greater and canopy cover greater than 60 percent) in a compact arrangement surrounding verified fisher birthing and kit rearing dens in the largest, most contiguous blocks available. Also when the buffer has been delineated a LOP would be applied from March 1 through June 30 as directed in the SNFPA 2004(S&G 85).

The den buffers were developed for each female that has denned at least once since 2007. This is the first year den data was collected. Timber stands were chosen that contain the natal and maternal dens. Next for each year the female denned, timber stands were chosen that lie completely or partially within the 700 acre home range which corresponds approximately to the 95 percent isopleth. The isopleth are the common points from the telemetry data where the fisher have been found. If the area was larger than 700 acres, stands were chosen that lie were the isopleth overlaps with other females and or the highest quality habitat resides. Buffers are supposed to be reviewed annually to determine if new dens need to be included. A table with all habitat types within each designated buffer is included in Appendix E.

3.3.1.3. Indicators

Although thresholds for these indicators have not been established, they provide general measures by which the effects of the Project alternatives may be compared. When assessing the effects of treatments on wildlife species it is important to remember treatments would not occur on some suitable acres. The number varies due to the different habitat types used by the particular species.

Indicator 1: Acres of Suitable California Spotted Owl Habitat

Acres of suitable habitat for the California spotted owl can be used to measure the effects of the alternatives. The acres of suitable habitat can be measured within Project area, within PACs, for the species over a 30 year period, and within the cumulative effects analysis area.

In the action alternatives, the acres of treatment may not be that different (see Table 20 below); the difference will be seen in the CWHR types over time.

Table 20. Treatment types within suitable California spotted owl habitat.

Treatment Types	Alternative 1	Alternative 2	Alternative 3
No treatments	3556	1276	1296
No harvest	0	2468	2468

Treatment Types	Alternative 1	Alternative 2	Alternative 3
Burn only	0	895	888
Thin (GTR 220) underburn	0	272	272
Thin (GTR 220) burn piles	0	312	312
Thin no underburn	0	0	0
Ladder	0	490	490
Chemical	0	19	0

Indicator 2: Acres of Suitable Pacific fisher Habitat

Acres of suitable habitat for the Pacific fisher can be used to measure the effects of the alternatives. The acres of suitable habitat can be measured within the Project area plus the Dinkey Landscape boundary, within fisher den buffers, within the 3.1 mile fisher buffer area, for the species over a 30 year period, and within the cumulative effects analysis area.

The estimated effects of the Project on fisher habitat were compared with the total available fisher habitat within the following five scales of geographic areas, spanning from the local project level (Level 1) to the regional level (Level 5). Cumulative effects are based on levels 2 through 5.

Level 1 = Fisher habitat within the Project boundary plus the 3.1 buffer area

Level 2 = Fisher habitat within the Project area plus the entire Dinkey Landscape Area

Level 3 = Sierra National Forest

Level 4 = Southern Sierra Fisher Conservation Area

Level 5 = Sierra Nevada Region

The Project ranges in elevation from 2,400 to 5,900 feet in elevation which is within the elevational range of the fisher. Of the six CWHR 2.1 high and moderate capability habitat types for fisher, three are represented in the Project to some degree (Table 21). Primary vegetation types include: Ponderosa Pine (52 percent of the Project area), Sierra mixed conifer (3 percent of the Project area), Montane hardwood (22 percent), barren is present in 8 percent and Montane chaparral habitat is present in 15 percent of the Project area.

Table 21. CWHR 2.1 high and moderate capability habitat for Pacific fisher.

CWHR2.1 Habitats	CWHR2.1 High and Moderate Capability Size, Canopy Cover, and Substrate Cover
Jeffrey Pine	4P, 4M, 4D, 5M, 5D
Montane Hardwood-Conifer	4P, 4M, 4D, 5S, 5P, 5M, 5D, 6
Montane Hardwood	4P, 4M, 4D, 5S, 5P, 5M, 5D, 6
Ponderosa Pine	4P, 4M, 4D, 5P, 5M, 5D
Sierran Mixed Conifer	4P, 4M, 4D, 5S, 5P, 5M, 5D, 6
White Fir	4P, 4M, 4D, 5S, 5P, 5M, 5D, 6

3.3.2. Environmental Consequences

3.3.2.1. Alternative 1 (no action)

Direct Effects

There are no treatments under the no action alternative and therefore, there are no direct effects related to terrestrial wildlife, specifically the California spotted owl and Pacific fisher. CWHR 2.1 habitat scores would remain at current values.

Indirect Effects

California Spotted Owl

There may be indirect effects to California spotted owl habitat because the no action alternative would lead to greater fuels buildup as well as changes in the forest stands that may not be typical for the natural range of variability. Additionally, in failing to reduce stand density, drought stress and subsequent insect and disease mortality would increase the threat of wildfire. If wildfire does occur under current conditions, it could substantially alter, reduce or eliminate wildlife habitat types.

Pacific Fisher

There may be indirect effects to fisher habitat under the alternative 1 as no fuels treatments would occur and the continued immediate threat of wildfire would remain unabated. Additionally, in failing to make an attempt at density management of the stands, the eventual changes through drought stress and subsequent insect and disease mortality acceleration would exacerbate the threat of uncharacteristically severe wildfire. Furthermore, the high probability of a drying climate change in the Western U.S. would potentially further compound these effects. Uncharacteristically severe wildfires pose one of the greatest threats to fisher habitat in the Southern Sierras. If an uncharacteristically severe wildfire were to occur in the Project area, current CWHR 2.1 habitat scores would change dramatically. Large areas of currently suitable habitat may become unusable. Fisher may be required to travel longer distances for foraging and reproduction, resulting in higher energetic costs. Projected changes due to wildfire are analyzed in depth in a subsequent section of this effects analysis.

Cumulative Effects

Since there are no direct effects and minimal indirect effects, the no action alternative would not contribute to overall cumulative effects to the California spotted owl or Pacific fisher. Wildfires may affect habitat in the Project, however, the extent that impact may occur cannot be exactly quantified. A more complete discussion of cumulative effects is found under the effects analysis for the alternatives 2 and 3).

3.3.2.2. Alternative 2 (proposed action)

Direct & Indirect Effects

California Spotted Owl

Disturbance: California spotted owls could be disturbed during the nesting season by noise from heavy equipment operations. There could also be disturbance from fire and smoke from controlled burns, and direct loss of potential habitat. Both foraging and nesting activities could be affected by these actions. Disturbance could lead to reduced time on the nest, thereby threatening eggs or young, with exposure. In general, these impacts are possible but not likely because design criteria # 29 listed in Section 2.1.4.1 would be implemented to reduce the noise disturbance to the spotted owl during the breeding cycle.

The issue of elevated sound and visual disturbance of forest wildlife species remains a complex and poorly understood subject. The FS, Region 5, has generally assumed that activities occurring farther than one quarter mile from a spotted owl nest site have little potential to affect spotted owl nesting (USDA FS 2004). This distance corresponds to the mean distance at which Mexican spotted owls were found to show an alert response to noise disturbance from chainsaws (Delaney et al. 1999). In addition, Wasser et al. (1997) found that stress hormone levels were significantly higher in male northern spotted owls (but not females) when they were located less than one quarter mile from a major logging road compared to spotted owls in areas greater than one quarter mile from a major logging road. These effects are likely more significant for male than for female spotted owls, and appear to be more significant in May when the chicks are still in the nest than in July when they have fledged and have some ability to escape the disturbance (Hayward and Wasser 2008). Chronic high levels of stress hormones may have negative consequences on reproduction or physical conditions of birds through these effects are not well understood (Marra and Holberton 1998, Gaines et al. 2003, USDI USFWS 2006).

Short-term responses in birds, as stated by Bowles in Knight and Gutzwiller (1995), have a similar (short term), continuum of responses as mammals, at the mildest level, they alert. Next, they exhibit mild aversion by flipping their wings (intention movements to fly), pecking at each other and walking, swimming or flying short distances. More intense aversion triggers longer movements, crouching on the nest, attacks on conspecifics or on the source of the disturbance (raptors, terns) and long interruptions of normal behavior. In the extreme case, individuals or flocks respond with panic flight or running.

Studies reviewed by Gaines et al. (2003) indicated that northern spotted owls were likely to be affected by the following factors: Collisions, disturbance at a specific site, physiological response, edge effects and snag reduction. These same factors, as well as “habitat loss and fragmentation” are expected to affect California spotted owls based upon review of the available literature (Verner et al. 1992, Blakesley 2003, Seamans 2005)

Habitat loss, fragmentation and edge effects: Studies have shown California spotted owls to be sensitive to changes in canopy closure and habitat fragmentation (Seamans 2005, Blakesley 2003, North et al. 2000).

Of the 3,556 acres of suitable habitat, there are 1,619 acres of spotted owl nesting habitat and 1,937 acres of foraging habitat being treated. The remaining 3,442 acres of the Project is not suitable nesting or foraging habitat; however, treatments are also occurring on the acres that are not suitable habitat. There are 1,017 acres that are being treated with the one or a combination of one of the following prescriptions: fuels treatments, harvest or burn treatments; the remaining 2,425 acres are not being treated.

The table below shows the treatments that would occur in the suitable habitat. There would be less habitat immediately after treatments; however, overtime the larger diameter class increases slightly which is a benefit to the owl. The potential reason for this is because there are larger diameter trees in the long term and the smaller trees are removed from the landscape so overall it can be a net benefit because the larger trees remain or grow overtime with the removal of the smaller trees in the Project area.

Table 22. Alternative 2 CWHR types within suitable spotted owl habitat over 30 year period.

Suitable Nesting/Foraging Spotted owl habitat	Current CWHR type/acres	Immediately after treatment	2022	2032	2042
MHC4D	134	131	146	143	116
MHC4M	104	100	52	41	32
MHC5M	35	35	42	53	61
MHC6	104	104	129	130	150
MHW4D	222	222	227	216	174
MHW4M	137	137	90	85	86
MHW5M	10	10	10	7	13
MHW6	38	38	80	75	93
PPN4D	675	559	539	511	414
PPN4M	1338	1199	1155	1179	1133
PPN5D	8	8	35	36	87
PPN5M	132	139	165	190	270
PPN6	262	244	319	321	377
SMC4D	8	8	1	6	6
SMC4M	117	144	143	143	87
SMC5D	0	0	7	16	33
SMC5M	5	5	5	5	14
SMC6	80	53	55	40	70
Total	**3409**	**3135**	**3200**	**3212**	**3216**

Pacific Fisher

This Project includes design criteria that incorporate and expand upon established riparian area management zones, (i.e. SMZs and RMAs associated with perennial streams (Class I). These zones are termed Old Forest Linkages (OFL), and they incorporate and expand upon the protection measures required for SMZs and RMAs. OFLs consist of buffers measuring 300 feet (600 feet total) on either side of perennial streams. These OFL corridors (primarily Rush Creek) also connect with untreated areas, such as untreated steep slopes, to create a wide-spread connectivity of dense understory and overstory habitat which can be used by fisher for some of their travel; thereby maintaining habitat connectivity and fisher dispersal routes throughout the Project area.

These changes to habitat may result in short-term effects in the way fisher utilize the habitat. Fisher may leave treatment units during Project implementation, and would likely rely more heavily on other areas of their home range. Individual energetic expenses may be increased if fishers have to travel farther to forage, however with areas of adjacent suitable habitat within their home range, it is unlikely this would result in individual mortality. A slight decline in individual fitness is possible, mostly occurring during the period of active vegetation management.

Long-term positive effects of fuels treatments (due to the reduction of fire hazard) and increased structural heterogeneity and biological diversity outweigh the short-term negative effects of fuel treatments (due to immediate loss of forest biomass) on fisher, especially when assuming a more severe fire regime in the future.

Collins et al. (2011b) has shown the finding that conservative thinning treatment resulted in only a slight increase in canopy base height indicates that seven to 10 years after treatment limiting thinning to this extent may not effectively reduce ladder fuels.

Different types of CWHR habitats would increase over time under alternative 2 which is a benefit to the fisher (Appendix E). The only difference between this alternative and alternative 2 is there is no herbicide treatment in alternative 3. There are smaller trees that would be removed by hand piling in the drainages. This would be a benefit to the fisher because it would provide more habitat over the long term because the trees that would remain would have more growing spaces. The drainages, such as the streamside protection zones, would remain with greater than 40 percent canopy cover maintaining desired habitat. Also another important component for fisher is ground cover and brush cover. It is utilized for the fisher as cover as well as their prey. As discussed in the Silvicultural Resources section above, bear clover and manzanita are the two most common species of brush found in the Project area (USDA 2012). The majority of the brush cover is found in the plantations. We estimate that at least half of that cover would remain immediately after treatment and increase within one to two years after treatment as a result of brush resprouting and new herbaceous vegetation in areas with increased sunlight.

Additionally, fishers are highly mobile and skittish creatures and would likely quickly vacate any area that is receiving mechanical treatment, thus minimizing potential direct effects as a result of mechanized activities. Prescribed fire treatments would move slowly enough through the forest to allow fishers to temporarily vacate the area, reducing the chances of direct mortality from fire or smoke inhalation.

Fisher may leave treatment units during and immediately after Project activities, although this is expected to be temporary and most likely those individuals, or others, would use these habitats after the treatments. If individuals leave the areas during treatments, they would likely rely more heavily on other areas of their home ranges during and immediately after treatment activity, given that their home ranges are substantially larger than the Project area.

Although the modeled habitat declines, key habitat features would be retained or enhanced, such as large trees, oaks and snags, as well as maintaining an average minimum canopy cover of 40 to 50 percent with a higher percent cover, and generally higher basal area, in portions of the two management areas, such as lower slopes and riparian areas. Also, by opening up the overstory canopy and clearing some of the decadent understory vegetation, the understory vegetation would become more diverse in age and structure, with a greater amount of new growth, thus helping lead to greater prey species abundance and diversity and a more open understory for flight patterns used in foraging.

There is minimal habitat change for the suitable fisher habitat under both alternatives (Appendix E). There are not enough treatments being conducted across the Project area to show a significant impact to the habitat. There is less than a one percent change in fisher habitat under both action alternatives. Out of the 92 planIDs which make up the Project area, 65 are not having treatment. The portions that are having treatment (27 planIDs) are within less than one percent of the suitable fisher habitat within the Project area. The treatment areas range within the different fisher probabilities. Table 23 shows the treatments in the higher fisher probabilities in planIDs 192, 253, 384, and 426 (see terrestrial wildlife BE for further details and tables for all planIDs).

Table 23. Treatments and CWHR changes in planID within fisher probability areas for all alternatives.

PlanID	Within fisher den buffer?	Total Acres	Treated Acres with prescription	CWHR type/acres	Alt 2 - change in acres	Alt 3 – change in acres
192	Yes- F24	137 acres	21 acres = Ladder fuels; tractor pile and burn piles; 19 acres change convert PPN3P-3M under Snowy Patterson	MHC4D – 4 ac PPN4D – 17 ac	4M 4D= 3ac 4M = 14 ac	4D=10 ac 4M = 8 ac

PlanID	Within fisher den buffer?	Total Acres	Treated Acres with prescription	CWHR type/acres	Alt 2 - change in acres	Alt 3 – change in acres
253	Yes – F22	101 acres	No treatments in this project; 4 acres convert from 2M to 4S under Snowy Patterson	0	0	0
384	Yes – F22	101 acres	Thin restore; grapple pile; burn piles	2M = 5 ac SMC6 - 27 ac	4S = 5 ac 4M = 27 ac	5M =27 ac
426	Yes – F12	88 acres	Ladder, grapple piles, burn piles	PPN4D = 16 ac	4D = 14 ac; 4M= 2 ac	4D = 14 ac; 4M= 2 ac

Cumulative Effects

California Spotted Owl

Cumulative effects to spotted owls were assessed at two different scales: forest-wide and river to river scale. At a forest-wide scale, there currently are 321 designated HRCAs and 258 PACs encompassing over 113,000 acres. Over 450,000 acres of suitable habitat currently exist on the SNF. Considering the proposed activities, ongoing actions, and reasonably foreseeable activities, less than one percent of suitable habitat on the SNF would be adversely affected.

The river to river scale area is bounded by the San Joaquin River on the north, the Kings River on the south, and the elevation range for spotted owls on the east and west. Wilderness areas and national park land, where limited land management occurs, further define the boundary on the east. The two rivers course through steep, rugged canyons that are dominated by chaparral or rock at lower elevations, have no habitat, and are inhospitable (although by no means impenetrable barriers) for north to south movement.

At the river to river scale, past activities have included clearcutting and salvage logging (1960s to 1972), sanitation and salvage harvests (1972 through 1978), clearcutting, shelterwood cutting, and salvage harvests (1978 through 1992), and commercial thinning and salvage in recent times. The only recent fires to burn substantial amounts of timber were the Rock Fire in 1981 and the Big Creek Fire in 1994, with each fire burning about 3000 acres of forest. Clearcuts or burned areas that took place prior to 1972 are most likely successful plantations today exhibiting size class 3 and density class M stands. Other, more recent disturbances, while they may be reforested have probably not yet reached size class 3. Overall, approximately 23,000 acres of disturbance have been documented for the larger area encompassing the HSRD since about 1972 (Smith pers. comm. in USDA Forest Service 2006c). Although these disturbances have caused notable changes in wildlife habitat, the amount of these changes over the last 30 years is not extraordinary compared to the total amount of suitable spotted owl habitat that is available. There are approximately 450,000 acres of suitable California spotted owl habitat in this cumulative effects analysis area, and the projects listed in Appendix C result in less than a one percent change in suitable habitat.

Other federal projects listed in Appendix C could reduce total potential habitat; however, since about 1997, SNF vegetation management projects primarily focused on forest restoration, which primarily involves thinning some live trees (a majority are less than 20 inch DBH) and retaining the overall inherent forest structure and biodiversity (as opposed to clearcutting). This forest restoration retains a wide range of tree ages and structures as well as retaining all trees greater than 30 inches DBH and most snags greater than 15 inches DBH, unless snags are classified as a hazard for fire or human safety.

These projects are also are designed to retain a variety of habitat features important to wildlife. This vegetation management creates forests with greater structural diversity and biological heterogeneity which provides better health, vigor, and growth and reduces forest susceptibility to severe, large scale wildfires, drought impacts, insect infestation and disease.

SNF vegetation management projects typically retain a minimum of 40 to 50 percent forest overstory canopy cover immediately after treatments and tree growth typically restores the canopy cover to pre-treatment levels within about 15 years. Each of these forest management projects also follow FS S&Gs (except for rare amendments for a few) that ensure specific levels of overstory canopy cover, large diameter trees, snags, coarse woody debris, and other wildlife habitat features. Additionally, many areas within treated areas, and adjoining treated areas, are not thinned, such as riparian SMZs, steep or rocky slopes and canyons, which provide a mosaic of unaltered forests mixed within thinned forests. Vegetation management projects on private lands (i.e. SCE lands) may bring canopy cover down to approximately 40 percent immediately after treatment, with tree growth restoring that canopy cover over the long term. Prescribed underburns on federal and private land typically maintain stand tree canopy cover above 50 percent. This is also true of the emergency salvage operations that remove dead and dying trees near residential structures.

The result of vegetation management, underburns, and hazard tree removal is a partial loss of tree canopy cover and habitat quality in some limited areas, but maintenance of foraging and nesting suitability, particularly considering that untreated areas treatment areas, and adjoining those areas, will retain higher canopy cover, such as riparian SMZs and non-mechanized zones such as steep and rocky slopes and canyons.

Hazard tree removal projects will not change potential California spotted owl habitat. However, hazard tree removal could slightly reduce the number of potential nest trees. Hazard tree removal projects in the KRP area have removed a total of approximately 8,500 trees. Approximately 1,000 trees greater than 30 inches DBH were removed out of a total population of 470,000 trees greater than 30 inches DBH. However, hazard tree removal results in a reduction of potential nest structures less than one-half of one percent of the total tree population. The action alternatives are expected to result in long-term positive effects to the California spotted owl by: 1) reducing the potential for catastrophic, stand eliminating wildfires; and 2) promoting the growth and re-growth of understory vegetation, which provides forage for prey species, as well as hiding and thermal cover. The horizontal and vertical diversity of forest vegetation structure and species also may be improved in some sites as a result of partially opening the forest overstory. This in-turn would bring greater heterogeneity, promoting greater biodiversity, possibly leading to greater prey species abundance and diversity, including promoting the establishment and improved growing conditions of black oaks, which are important components of California spotted owl habitat. These factors, combined with the project measures implemented to sustaining spotted owls, outweigh the short-term negative effects of treatments (due to immediate partial loss of forest biomass and disturbance), especially considering that this action would reduce the potential for a large scale, high-severity wildfire. Without fuels reduction, large scale, stand-replacing wildfires would most likely cause serious and significant impacts to the population. The temporary loss of California spotted owl habitat due to vegetation management would be insignificant contributions to other events occurring from the past, present, and foreseeable actions listed in the Appendix C.

In its 12-month finding in which it decided to not list the California spotted owl as T or E, the USFWS concluded that the scale, magnitude, or intensity of effects on the California spotted owl resulting from fire, fuels treatments, timber harvest, and other activities did not rise above the threshold necessitating protection of the species under the Endangered Species Act (USFWS 2006). The USFWS reached this conclusion after considering the impacts of the FS's implementation of the SNFPA ROD. The USFWS' (2006) conclusion is supported by:

- Data which indicate that California spotted owl populations in the Sierra Nevada are stable and comprise 81 percent of the species' known territories;
- The anticipation that current and planned fuels-reduction activities throughout the range of the species would have a long-term benefit by reducing the risk of stand-replacing wildfire; these activities embrace those described by the SNFPA ROD;
- Barred owls represent only about two percent of California spotted owl numbers in the Sierra Nevada;
- Protection measures are being implemented for the California spotted owl on private lands, including the largest private landholder within the range of the species.

Based on the above analysis, the activities of the proposed action are within the scope of effects considered and described by the USFWS in its 12-month finding to not list the California spotted owl. Therefore, the proposed action, including the temporary loss of some spotted owl habitat, would not result in any cumulative effects that are greater than those already analyzed by the USFWS when it determined that listing of the California spotted owl as T or E is not warranted at this time. For all of these reasons, viability of the owl in the Project area is not a concern.

Pacific Fisher

The Level 1 assessment defines fisher habitat availability within the Project plus a 3.1 buffer around the Project area. The 3.1 mile Project area buffer represents the area where an average female fisher home range (95 percent kernel home range of 4,735 acres) may overlap or touch the Project area. The average home range was derived from 27 radio collared female fishers studied from 2007 to 2009 in the Kings River Fisher Study Area of SNF (Thompson et al. 2010). The intent of this method is to assess the potential effects of the Project not only on fishers only using the Project area, but also those that may have home ranges that overlap or touch the Project area.

The assessments of Level 1 and Level 2 (DLRP Area) used the FVS to project future stand conditions of vegetation management projects currently planned but not yet fully implemented, including the Dinkey North, Dinkey South, Eastfork, and Snowy Patterson projects that are within the DLRP area. This assessment does not include planned or proposed projects that do not have reliable or predictable silvicultural prescriptions. The fisher habitat acreage determined from this updating process was then considered to be latest information of fisher habitat availability. The amount of fisher habitat impacted by the proposed Project was then compared with that new updated fisher habitat acreage to determine the degree to which the Project would impact fisher habitat. This result is presented as the percent of effect on fisher habitat availability, as shown in Table 24.

Table 24. Effects of action alternative on Pacific fisher habitat in the Project area when compared with habitat available at different scales.

	Soaproot Project Area		Project Area + 3.1 Mile Buffer		Project Area + Dinkey Project Area		Sierra NF	
Soaproot Action Alternatives	**Current Acres Fisher Habitat**	**Estimated Change in Acres - Post-Treatment**	**Acres**	**% change in habitat**	**Acres**	**% change in habitat**	**Acres**	**% change in habitat**
2	3111	551	57095	0.96%	106,189	0.52%	720,456	.076%
3	3111	128	57095	0.22%	106,189	0.12%	720,456	.018%

There are 57,095 acres within the 3.1 mile buffer of the fisher area. The results of this assessment (Table 24) show that the minor and temporary decrease of fisher habitat from the Project are less than one percent of the total fisher habitat available at the Level 1 geographic assessment.

Past, present and future vegetation management projects (see Appendix C) affect less than one percent of high suitability fisher habitat in the Project area. The negative effects of these projects are short term, while the long-term cumulative effects are mostly beneficial to fisher (reducing the risk of stand-replacing wildfires). Wildfires have impacted around five percent of the suitability fisher habitat within its range. Moderate intensity fires have short-term negative impacts, but are beneficial to fisher habitat in the long term.

About 95,725 acres of private lands (such as SCE, Pacific Gas and Electric and residential areas) occur within the SNF. Together, they encompass about 15 percent of it. These private lands are dispersed throughout oak woodland, shrubland and forested habitats, so it is reasonable to assume that only a small percent of each habitat has and will be impacted by activities on private lands.

There are 28 active cattle allotments, encompassing about 743,247 acres and permitting 17,000 animal unit months (AUMs) within the analysis area. Some of the cattle allotments encompass late seral closed canopy coniferous forest habitat. Nevertheless, it is assumed that cattle would not impact this habitat because closed canopy stands would not contain a lot of understory grasses and shrubs to attract them.

CDFG (2005) lists loss of habitat via timber harvesting as a factor impacting all three MIS species. About 526,639 acres of timber sales have/will occur within the analysis area within the timeframe of the cumulative effects analysis. Some of these sales have likely reduced the amount of habitat available for MIS by opening up the canopy cover. About 612 acres of late seral closed canopy coniferous forest habitat has had some type of timber sale within them. These sales have likely improved the growth, vigor, health and resistance of the stands.

As well, 6,089 acres of hazard sales have/will occur within the analysis area have likely removed some trees within late seral closed canopy coniferous forest habitat. However, removal would likely be dispersed enough to prevent significant impacts upon the habitat.

CDFG lists fuel reduction/prescribed fire activities as one of the factors that impacts late seral closed canopy MIS. Nevertheless, USFWS states that the short-term negative impacts are ameliorated by the longer-term benefit of reducing the greater risk of catastrophic wildfire. About 1,535 acres of prescribed burns have/will occur in late seral closed canopy coniferous forest habitat within the analysis area. Prescribed burns have/will likely benefit the habitat by removing excess fuel buildup and making the habitat less susceptible to wildfires.

The Level 2 assessment area (the DLRP area) has approximately 106,189 acres of fisher habitat, and the expected Project impacts are expected to be only approximately 0.52 percent under alternative 2 and 0.12 percent under alternative 3 of that total (Table 24).

Appendix C lists the ongoing federal management activities in the DLRP area of HSRD of SNF. These projects include the prescribed burn program, other fuel reduction projects, timber and culture projects, active cattle allotments, and recreational activities and events (e.g., off-highway vehicles [OHVs] and off-snow vehicles [OSVs]). All of these projects are predicted to ultimately result in greater long-term retention of fisher habitat within project boundaries over the long term.

Private land forestland management was taken into consideration with our cumulative effects assessments. This management may have some effects on fishers inhabiting that area, such as reducing potential den and rest sites with high canopy cover, as well as potentially producing greater understory vegetation species and abundance of herbaceous and shrub vegetation, which in-turn will increase habitat for many fisher prey species.

All of the vegetation management projects on federal in the DLRP area, within the fisher habitat elevational zone, typically retain an average minimum of approximately 50 percent overstory canopy cover immediately after treatment, and in most cases at a higher minimum level, such as 60 percent or greater, with canopy cover restoring to pre-treatment levels approximately 15 years post-treatment. Uneven-aged management on the private lands most likely would have the lowest canopy cover immediately after treatment, which typically is an average of at least 40 percent overstory forest cover. The fact that all these projects would provide for greater forest heterogeneity and greater understory vegetation abundance and diversity is a benefit to species that use this forest habitat, as well as reducing their susceptibility to wildfire, drought, insects, and disease, which would help perpetuate these mature and old-age forest habitats on the landscape.

The 17,300 acre prescribed underburning program has been and continues to be for maintenance of defensible fuel profile zones, reducing surface fuel loads and providing fire into this fire adapted forested landscape. Approximately 8,495 hazard trees of all size classes have been removed from the Dinkey landscape area throughout the last five years. This represents approximately 2.4 trees per acre. Hazard tree removal may eliminate some potential fisher rest sites but because most hazard trees are identified in proximity to roads, campgrounds and other developed sites, the likelihood for use by fishers is minimal.

Fisher habitat availability within the SNF (Level 3 assessment) is approximately 720,456 acres, and the proposed Project would impact only approximately 551 acres under alternative 2 and 128 acres under Alternative 3 of fisher habitat, which is only 0.076 percent and 0.017 percent respectively of that total (Table 24).

Rick Truex, a FS fisher scientist believes fishers may have increased their spatial distribution on the SNF since the mid-1990s and that the annual occupancy rate within the SNF seems to be consistent, though the spatial pattern of detections appears more variable among years than on the Sequoia NF (Truex pers. comm.). Additionally, two fisher research projects on the SNF (KRP and SNAMP) conducted from2007 through 2010 have shown fisher populations remain stable or potentially slightly increasing (Craig Thompson, pers. comm. 2011). The combination of a stable or slightly increasing amount of suitable fisher habitat on the SNF and perhaps an increasing spatial distribution of fishers make it reasonable to conclude the cumulative effects of vegetation management activities on SNF have not reduced overall habitat suitability for fisher sustainability on the SNF.

A majority of management occurring in fisher habitat on the HSRD is within the DLRP area, as described in the Level 2 assessment. The Bass Lake RD, SNF currently has five land management projects of the size that could influence the cumulative effect on fisher habitat (Appendix C). Treatments have recently been completed or contracted for Sonny Meadows North (with 955 acres of treatments); Sonny Meadows South (with 1,400 or more acres of commercial thinning); Cedar Valley (with approximately 915 acres of commercial thinning); Sugar Pine (2,900 acres of fuel reduction prescriptions); Fish Camp (753 acres for thinning of which 400 acres are in plantations); and Grey's Mountain (3575 treated acres). Other future vegetation management projects, such as the Whiskey Ridge Forest Restoration Project were not included in this assessment since they do not yet have reliable silvicultural plans and prescriptions.

All of the current and foreseeable projects on NF lands would include management provisions that sustain fisher populations, as directed by FS S&Gs and other wildlife conservation management requirements. All of these projects also will be analyzed through the NEPA process, which will help ensure management effects on species are addressed. As a result, the potential effects of all action alternatives of the Project are not expected to create significant adverse cumulative effects to fisher habitat. Fisher habitat, including mature and old age trees, would have a greater chance of remaining on the landscape over the long term as a result of these proposed fuel reduction treatments since they would reduce the potential for large scale, high-severity wildfire that could eliminate them for decades if not centuries. These projects also would not increase habitat fragmentation since the entire Project area would have moderate to high overstory forest canopy closure after treatment suitable for fisher.

3.3.2.3. Alternative 3

Direct and Indirect Effects

California Spotted Owl

As is seen in Table 25 below there is minimal change in habitat types because there are minimal treatments being conducted. Also the modeling that was conducted by the District silviculturist shows insect mortality is killing the large trees; therefore, there is a reduction in the habitat types (USDA 2012). The direct and indirect effects for alternative 3 are the same as alternative 2, except it is happening on a fewer acres overall.

Table 25. Alternative 3 CWHR types within suitable California spotted owl habitat over 30 year period.

Suitable Nesting/Foraging Spotted owl habitat	Current CWHR type/acres	Immediately after treatment	2022	2032	2042
MHC4D	156	134	146	143	116
MHC4M	126	104	57	51	40
MHC5M	35	35	42	50	58
MHC6	104	104	133	134	154
MHW4D	222	222	227	216	174
MHW4M	137	137	90	87	86
MHW5M	10	10	10	7	13
MHW6	38	38	80	73	92
PPN4D	736	577	569	487	418
PPN4M	1370	1442	1289	1324	1087
PPN5D	8	8	35	36	87
PPN5M	137	132	166	159	313
PPN6	267	254	357	341	397
SMC4D	8	8	1	6	6
SMC4M	117	117	116	116	87
SMC5D	0	0	7	42	33
SMC5M	5	32	5	5	14
SMC6	80	53	81	40	70
Total	3556	3408	3405	3318	3243

Pacific Fisher

For alternative 3, different habitat increases overtime which is a benefit to the fisher. The only difference between this alternative and alternative 2 is there is no herbicide treatment in alternative 3. Therefore, the direct and indirect effects of alternative 3 on the Pacific fisher would be similar to those described under alternative 2.

Cumulative Effects

Because the direct and indirect effects on the Pacific fisher would be the same as alternative 2, the cumulative effects would also be the same.

3.4. Watershed and Riparian[16]

3.4.1. Background and Affected Environment

One of the identified Project needs is to improve watershed resilience and function, and habitat for aquatic-dependent species. The analysis performed for watershed and riparian resources addresses this need, as well as legal requirements for compliance with the Clean Water Act and applicable state water quality regulations, which focus on the protection of the beneficial uses of water. The full analysis is contained in the Water Resources Specialist Report (Gott 2012) and is summarized here. The analysis evaluated effects on water quantity, water quality, stream channel shape and function, herbicide use, and CWEs.

BMPs (Appendix B) are the main method for implementing watershed and riparian related S&Gs from the SNF LRMP, meeting other regulatory requirements, and minimizing potential negative effects on these resources. Literature has shown that BMPs are effective in minimizing erosion in harvest units and at preventing sediment from reaching streams. In a post-harvest study, Wallbrink and Croke (2002) found that sediment eroded from skid trails was deposited in the harvest unit and in 75 to 100 foot wide stream buffers. Water bars were found to be very effective at reducing coarse sediment loads, and finer sediment was deposited within 15 feet of water bar outlets. The stream buffers trapped more sediment per unit area than the harvested area. In a review of published studies of buffer strip effectiveness, Norris (1993) notes that studies he reviewed indicated that buffer zones are effective at reducing sediment concentrations in runoff. In addition, the effectiveness of BMPs is monitored each year on the SNF (USDA FS 2002). SNF monitoring results from 2007 to 2011 show that sediment delivery to water was observed in two of 70 effectiveness evaluations of timber sale and vegetation management BMPs (three percent). The noted impacts to water quality were characterized as 'Minor, Near Site'. Overall, water quality was protected in 97 percent of the monitored sites. BMPs would be expected to protect water quality during implementation of this Project.

3.4.1.1. Water Quantity, Water Quality, and Stream Channels

Water quantity, water quality, and stream channel shape and function are interrelated. Stream channels develop an equilibrium based on the amount of water and sediment that they carry; changes in these inputs can cause channels to become unstable as they change form to accommodate the new input levels. This process can cause erosion of the stream channel itself, which provides another source of elevated sediment supply. The main water quality concern in the Project area is sand-sized sediment that can be derived from roads, hillslope disturbances, or in-stream erosion.

Water quantity in the Project area has probably been modified from natural conditions, but the extent of the changes is unknown (Gallegos 2004). Roads and previous vegetation management that have created compaction and removed vegetation and groundcover have probably reduced flow concentration time[17], and increased peak stream flows. Some of the Project area drainages have large areas of exposed bedrock, which result in naturally high runoff rates and 'flashy' flows (short concentration time and high storm peaks).

[16] The watershed and riparian section is a summary of the Water Resources Specialist Report and the CWE Analysis Report prepared for the Soaproot Restoration Project. These reports are herein incorporated by reference and are available in the Project planning record located at the HSRD office.
[17] Flow concentration time is the time required for precipitation falling at a ridgeline to reach a certain point in a watershed. Short concentration times typically produce quick increases in stream flows in response to precipitation.

Stream channels in the Project area range from steep bedrock controlled reaches to moderately steep meandering reaches with erodible stream bed and banks. The latter type of stream reach is more likely to respond to changes in water and sediment supply. Throughout the Project area, the less steep, 'response' stream reaches tend to be incised (downcut) and have little or no floodplain, which means that storm flows are contained inside the channel and are likely to cause channel erosion. These reaches also tend to have high levels of sand-sized sediment. Excess sediment is typically deposited in pools, where water velocity slows and sediment transport capacity diminishes.

3.4.1.2. WIN Sites

WIN site treatments are identified in the description of the alternatives. Most of the sites are related to road surface erosion, road runoff causing erosion or deposition, or road stream crossings. Only two sites identified for treatment (54282 and 54431) are not associated with a road, and these are actually two headcuts on an ephemeral stream channel that are within 50 feet of each other. The site-specific existing conditions of the WIN sites are described in the environmental consequences section to provide more continuity in the discussion of these sites.

3.4.1.3. Indicators

The effects of the alternatives were evaluated using a suite of indicators. The indicators that were the most meaningful and relevant to quantifying the effects on the landscape for water resources are presented here. Additional indicators are included in the Water Resources Specialist Report (Gott 2012).

Indicator 1: Reduction in Basal Area

Research has found that increases in flows that result from vegetation removal are related to the proportion of basal area removed. In general, researchers have concluded that if less than 10 percent of the existing basal area is removed, there is little impact on flows. This is supported by paired watershed studies and by modeling (Troendle et al 2010).

Indicator 2: V*

V* is a measure of the amount of fine sediment in pools, and is an accepted indicator of sedimentation problems (Lisle and Hilton 1999, Kappesser 2002, Beche et al. 2005, Frazier et al. 2005, Cover et al. 2008). In the Project area, the desired condition for V* is a maximum of 20 percent. Existing V* values are shown in Table 26 below. Of the reaches where V* has been measured, only Summit Creek and portions of Big Creek meet the desired condition.

Table 26. V* values in the Project area.

Subdrainage	Stream	V*
519.0006	Tributary 17 to Big Creek	60%
519.0008	Providence Creek	26%
519.0009	Akers Creek (Tributary 21 to Big Creek)	25%
519.0057	Big Creek	20 – 40%
519.4051	Summit Creek	17%

Indicator 3: Acres of herbicide use in RCAs, SMZs, and RMAs.

Glyphosate rapidly attaches to organic matter and soil particles on the ground surface and on plant surfaces (Ghassemi et al 1981). Its mobility is very limited. It does not become mobile again with precipitation and does not leach through soil. Because of its low mobility in soil, the only mechanism for off-site movement of glyphosate is erosion and transport of soil particles to which it is attached. If such sediment particles reached water, the glyphosate would not be in a form that could be taken up by plants or released through digestion by animals - normal hydrolysis in a stream will not break the attachment of glyphosate to soil particles. Because of its affinity for organic material and soil particles, glyphosate is not mobile once it is applied by ground application, so it does not affect either surface or ground water quality. The greatest risk of introducing glyphosate into the water would be by accidental spills directly into water.

From 1991 to 2000, surface water adjacent to projects involving the use of glyphosate was monitored on seven projects on the Sierra, Stanislaus and Eldorado National Forests. A total of 104 samples were taken. All resulted in no detections (Bakke 2001).

Based on literature review, there is very little risk posed to water quality from herbicide applications in the Project. In order to ensure adequate consideration of possible risks and compliance with the SNF LRMP, spraying in the special land allocations designed to protect water resources (RCAs, SMZs and RMAs) will be evaluated.

Indicator 4: Effects of WIN Site Treatments

WIN site treatments would affect stream channel sedimentation (V*) and also indicate maintenance or improvement of watershed condition. They are discussed by individual site since the problems and treatments vary.

Indicator 5: Equivalent Roaded Acres (ERAs).

Following the direction in FSH 2509.22, the CWE analysis has two components: the Baseline CWE Analysis and the Detailed CWE Assessment. The Baseline Analysis was conducted using the ERA model to determine if the ERAs in any subdrainage are currently at or over their lower Threshold of Concern (TOC). In the ERA model, the percent ERA is used as an index of watershed disturbance and the risk of impacts to watershed function. Each acre of activity is multiplied by a coefficient to express its level of disturbance to watershed function. Disturbance activities included roads and OHV trails; past, present, and foreseeable vegetation management and logging activity; grazing; and land development. All known disturbances that occurred over the past 30 years and all reasonably foreseeable disturbances are included in the ERA analysis. Currently, eight of the 15 subdrainages that contain proposed treatments are over their lower TOC, and one (519.0010) is over the upper TOC of 14 percent. Management activities are usually planned to avoid exceeding 14 percent ERAs in any subdrainage.

3.4.2. Environmental Consequences

3.4.2.1. Alternative 1 (no action)

Direct and Indirect Effects

There are no treatments under the no action alternative, therefore there are no direct or indirect effects under this alternative. The conditions and processes described in the existing condition would continue. Sedimentation (elevated V*) would be a concern in lower gradient stream reaches, especially in Big Creek and Rush Creek.

Cumulative Effects

Because there are no direct or indirect effects of this alternative, there would be no cumulative effects. The ERAs that would result from this alternative are the same as described for the existing condition. ERAs would reflect other current and foreseeable disturbances but would generally diminish over time to reflect recovery. Where CWEs that are thought to be occurring, particularly in Big Creek and Rush Creek, they would continue.

This alternative would not address the need for the Project to improve watershed resilience and function, or habitat for aquatic-dependent species.

3.4.2.2. Alternative 2 (proposed action)

Direct and Indirect Effects

Reduction in Basal Area

The reduction in basal area was calculated as the weighted average of the change in basal area, based on the vegetation modeling. The amount of change necessary to indicate a possible effect on water yield is approximately 10 percent, and the amount of change that would produce a detectable change is approximately 20 percent. Because the maximum change in basal area in any subdrainage is 6.1 percent, this alternative is not expected to affect stream flows.

*V**

Sedimentation (V*) could be slightly increased in some subdrainages in the short term (for up to five years). Although treatments would follow all BMPs, including no equipment buffers (SMZ/RMAs), there is potential for sediment to be delivered from unscoured swales, which are not protected by SMZs. Mechanized operations including skidding of logs and tractor or grapple piling of fuels would occur in these areas. Disturbances could increase sediment available for transport downslope by overland flow and into scoured channels. This could occur in any subdrainage with mechanical treatments. Literature supports that the volume of sediment available generally drops dramatically after the first year and recovers within three years (Stednick 2000). The potential effect would be minimized by Project design criteria directing that Order 1 streams (typically Class V per the definition in the SNF LRMP, requiring no SMZ) are treated as Class IV streams, and receive a 25 foot SMZ (see Table 2). Reductions in sediment delivery that result from WIN site treatments including road reconstruction and maintenance would also offset any increases, and could reduce fine sediment (V*) in Big Creek within three to five years.

Burning prescriptions would be designed to minimize riparian disturbance. Although fire would enter RCAs and SMZ/RMAs, the amount of high soil burn severity is not expected to be concentrated in these sensitive areas because they wouldn't be directly lit and they tend to hold more moisture than surrounding areas. Groundcover would be consumed in some areas, but in any given stream reach, remaining groundcover is expected to meet the 50 percent S&G for SMZs. This is supported by the BMP monitoring of past prescribed burns on the SNF.

Road maintenance and reconstruction could also increase sediment delivery in the short term, particularly work performed at stream crossings and along inboard ditches (Luce and Black 1999). However, this work provides longer-term benefits to water quality by reducing road erosion and hydrologic connectivity. In areas with high levels of existing hydrologic connectivity, greater reductions in sediment delivery would result from road reconstruction that would minimize the length of road delivering runoff and sediment to streams. Also, reductions in road runoff delivered to streams would increase flow concentration time, reduce peak flows, and reduce the potential for in-channel erosion during high flows.

Herbicide Use in RCAs and SMZ/RMAs

Treatments in RCAs and SMZ/RMAs would not directly spray riparian vegetation. Although previous monitoring (Bakke 2001) and literature review (Ghassemi et al 1981) indicate little concern for glyphosate impacts to water quality, its use in RCAs and SMZ/RMAs is evaluated for consistency with RCOs and the SNF LRMP.

Herbicide applications would overlap RCAs in eight subdrainages for a total of 123 acres, and SMZ/RMAs in six subdrainages for a total of 30 acres. Because monitoring has shown that BMPs protect water quality, this treatment is not expected to have an impact (Bakke 2001) on water quality in the short-term or long-term timeframes. It is also not expected to affect riparian vegetation because BMPs and Project design criteria specify that riparian vegetation would not be sprayed and that measures would be in place to minimize drift. No effect would be expected in other proposed areas because they are not in proximity to water or riparian vegetation.

WIN Site Treatments

The effects of the WIN site treatments are discussed individually below.

54138 – This site documents sediment delivery from FS road 10S43 to Rush Creek. Road runoff has been concentrating along the road and flows down the fillslope, through a dispersed camp site, and into Rush Creek. Road maintenance would prevent runoff from concentrating on the road so that the flow over the fillslope at this location would be reduced or eliminated. Consequently, the potential for erosion would be reduced. Locally derived forest litter and seed heads from on-site vegetation would be scattered over the area, and jute netting would be installed to hold these materials on site and promote vegetation establishment. Erosion from this site would be minimized by these treatments, and sediment from this site would no longer have potential to be delivered to Rush Creek. This would improve site condition and possibly reduce fine sediment in the channel adjacent to the site, but would have no noticeable effect in Rush Creek downstream because it accounts for a very small proportion of the creek’s total sediment load.

54274 – A portion of a motorized trail (FS road 10S90) is incised up to four feet deep, and the eroded sediment is being delivered to Rush Creek. Efforts to stabilize this segment with rock, including installation of boulder steps, have been unsuccessful, and suggest that this alignment is not sustainable. The Project would realign the route to avoid the problem area, and close and rehabilitate the incised segment. The new alignment is approximately the same length as the segment that would be rehabilitated, so the overall route length (and associated ERAs) would not change. Removing traffic from the segment would reduce erosion and sediment delivery immediately, and stabilization treatments including routing of runoff and vegetating the area could return it to near background levels as recovery progresses. The proposed alignment would not allow concentration of runoff, which would minimize erosion. There is one ephemeral stream crossing on the new alignment that would receive some sediment from the trail. This sediment would eventually be routed to Rush Creek, but the quantity would be far less than has been produced by the existing alignment. This problem has been a major source of fine sediment to Rush Creek and the treatment is expected to reduce sedimentation in the receiving stream reach; however, overall sediment supply to Rush Creek would not be noticeably reduced because of the large number of remaining sediment sources.

54340 – Road and stream crossing erosion at multiple locations on FS road 10S04A would be addressed through road reconstruction for temporary use, followed by decommissioning. A temporary structure would be installed at the main stream crossing (which currently has no crossing and is impassable) because the cost of a permanent solution at that site is prohibitive and future need for the road is limited. Because the temporary crossing would not be permitted to remain in place during high flows, the timing of Project activities in this area including thinning and fuels treatments would be compressed into a single operating season. Following treatments, this road would be decommissioned beyond the 10S04AB junction, including rehabilitation treatments to ensure that it would recover over time and would not affect runoff patterns, erode, or deliver sediment to streams. These treatments would include removal of cross drain culverts, some ripping to break up compaction, and installation of waterbars to prevent concentration of runoff and erosion. On-site materials would be used to provide a minimum of 50 percent groundcover. Documented erosion problems would be stabilized and would recover over time. Some of the erosion associated with this WIN site appears to be due to subsurface pore water pressure that causes a sinkhole-like effect; that process may continue even after this treatment is completed. Overall sediment delivery from the WIN site would be reduced, but probably would not make a difference in subdrainage-wide stream channel condition or downstream sedimentation in Rush Creek. This would improve site condition and reduce ERAs in this subdrainage.

54381 – Sediment is delivered from FS road 10S04 at the Rush Creek ford crossing. This ford crossing would be used by heavy trucks and machinery to access and remove material from the treatment areas west of Rush Creek. An estimated 40 loads of logs would need to cross this channel, which could be completed in approximately one week. In order to accommodate this use and stabilize the crossing, the approaches would be rocked to reduce surface erodibility, and rolling dips would be constructed to minimize the length of road that drains directly into the crossing. Clean angular gravel (not tunnel muck) would be placed in the channel to provide a more stable and level driving surface. Any necessary permits would be acquired prior to implementation. There could be effects to water quality from fluids washing off of trucks and equipment that cross, but this would be minimized by the rock placement, which would minimize water depth. Vehicles would be inspected for leaks prior to crossing, and would not be permitted to cross if flows are deep enough that the undercarriage would be submerged. Effects on sedimentation would be minimized by the use of large gravel sized rock with a minimal component of fine material. Impacts to channel shape and function would be minimized since vehicles would drive on a hardened surface rather than on the channel bed. The potential for eddying and upstream erosion would be minimized by placing the crossing material at appropriate geometry so that flow energy is concentrated towards the center of the channel. The material is expected to be transported during normal high flows in this creek, so it would be dispersed within a few (one to five) years, depending on precipitation and stream flows. Alternatively, the material could be removed after use and spread on the adjacent road segments, although this would have the potential to cause additional mechanical disturbance to existing fine sediment on the channel bed.

54289/54306 – Road surface erosion, stream crossing erosion, and erosion in a meadowy opening adjacent to FS road 10S404 (WIN site 54133, described in the following paragraph) would be addressed through road reconstruction. A survey of hydrologic connectivity conducted in 2011 found that approximately 23 percent of this road's length delivers water and sediment to the stream network. In addition, 70% of the culverts, including one perennial stream crossing, were at least half plugged with sediment and characterized as undersized. Three more locations were either completely buried or had no cross drain. Reconstruction of this road would include improvements in surface drainage structures, cross drains, and stream crossings. One perennial stream in particular (Trib 1 to Akers Creek, 519.0009) has culvert plugging, upstream ponding, and flow diversion issues that result in erosion and sediment delivery. These treatments would improve road drainage, minimize erosion on and adjacent to the road template, and reduce hydrologic connectivity. Sediment delivery to Trib 1 to Akers Creek would be reduced, but it's unlikely that this would result in a discernible improvement in water quality in the channel downstream because there are probably numerous other sediment sources.

54133 – Erosion, including minor headcutting, is occurring in an ephemeral channel in a small meadowy area adjacent to 10S404. The cause appears to be that road runoff is routed into this channel, and since the channel is so small, peak flows have been greatly increased over natural peak flows. Road reconstruction would specifically minimize the length of road that is drained into the meadow in order to reduce flows, thereby reducing peak flows and channel erosion. The channel would then be stabilized through a combination of revegetation treatments and placement of rock, based on the degree of channelization and instability present. This would minimize channel incision and help protect the water table in this area, which in turn would support riparian values. It would also reduce sediment delivery into a tributary to Trib 1 to Akers Creek (519.0009), but the amount of sediment generated at this site is minor, so there would be no noticeable downstream effect.

54282/54431 – Headcut erosion is occurring in an annual grassland opening (the area is not a riparian meadow). The site was previously stabilized with a geoweb structure that is failing, and the headcut is progressing upstream. The geoweb material would be removed from the channel. This headcut and a smaller one just upstream would be reshaped and stabilized by constructing rock structures to dissipate energy and provide grade control. The larger headcut would be stabilized with two rock step pools, and the smaller headcut would require only one rock step. These structures would more closely match the natural characteristics of nearby channel reaches, where large boulders and bedrock provide stability in steep, cascading stream segments. This would reduce channel erosion and improve stream function at the site, and improve overall site condition in this annual grassland opening. However, the reduction in sediment would not result in a discernible improvement in downstream water quality in this tributary or in Big Creek (519.0057), even cumulatively.

54435 – This WIN site documents erosion on a skid trail (in 519.0057) that is the result of concentration of overland flow due to compaction and the lack of functional waterbars being placed on the trail after its last use. The erosion would be mitigated during and after re-use of the trail by ripping to reduce compaction, and installation of cross drains at appropriate spacing and other erosion control measures as necessary (BMP 1.17). Erosion at the site would be reduced or eliminated. However, because the eroded soil has not been delivered to any stream, there would be no effect on water quality or stream channel shape and function.

54433/54436/ 54473b – These sites describe widespread erosion on FS roads 10S75 and 10S75C. A preliminary survey in 2011 found that approximately 18 percent of these roads are hydrologically connected to the stream network. The volume of eroded material was estimated to be 26 cubic yards in 2005, at which time the deepest gully was two feet deep. In 2010, longer gullies up to four feet deep were documented on 10S75, suggesting that the volume of material lost to erosion has probably at least doubled. It has not been determined how much of the eroded sediment has been delivered to streams, but the eroding segment approaches and crosses channels in both 519.0057 and 519.4051. Reconstruction of this road would specifically target improvements in drainage to minimize gullying and hydrologic connectivity, including constructing drainage structures at closer intervals and installing energy dissipation where needed to encourage dissipation and infiltration. The road is already graveled, and additional rocking would be required to control erosion. This road work is expected to reduce sediment delivery to tributaries to Big Creek in 519.0057, and may reduce overall sediment contributions enough to slightly improve conditions (i.e., reduce V*) in Big Creek itself. Reducing the amount of road runoff delivered to these channels could also attenuate peak flows and reduce in-stream erosion that has been occurring in sensitive stream reaches.

54288/54469/ 54467 – These sites document stream crossing and culvert problems on FS roads 10S75A and 10S75B. Road reconstruction would address these locations by installing properly designed culverts at these crossings, which are on tributaries to Summit Creek (519.4051). The culverts would be sized to accommodate the 100 year flow at each site, placed at proper channel grade, and stabilized as necessary. One site has a three foot headcut at the downstream side of the road which would be stabilized with rock to dissipate energy. While this would improve site condition and stream channel shape and function in the immediate stream reaches, improvements to downstream channel conditions are not expected to result.

54437/54438/ 34439/54440/ 54500 – These WIN sites document widespread gully erosion on FS road 10S75D. This motorized trail (open by Special Use Permit only) was misclassified as a road, but has steeper slopes than are appropriate for system roads. When last surveyed in 2004, an estimated 50 cubic yards of sediment had been eroded, and much of it is deposited in a large sediment lobe that reaches a perennial channel (Trib 25 to Big Creek, 519.0057). This route would be reconstructed and drainage structures would be located at appropriate distances per LRMP S&G 128. The structures would be rocked for stability due to the soil types present. A sediment basin would be constructed to catch sediment prior to it reaching the stream. This would improve site condition and reduce sediment delivery to the stream. Cumulatively with the work on roads 10S75 and 10S75C, which cross tributaries to this stream in 16 locations, a measurable reduction in fine sediment (decrease in V*) could result in Trib 25 to Big Creek.

54428 – A road cross drain culvert on FS road 10S18 is creating gully erosion up to 17 feet deep. An estimated 600 cubic yards of sediment has been eroded from this site (in 519.0057). The gully initiation point is within 450 feet of Big Creek and on a steep slope, so it is likely that at least some of this material has been delivered to the creek (519.0057). This gully would be filled with three inch gravel (derived from a nearby existing quarry on 10S02) and capped with tunnel muck material, which contains a range of particle sizes that fit together and form a good seal. Water would flow over this material instead of percolating through it. The fill would be shaped to provide passage of water without allowing it to contact adjacent soil – if the water flows against soil, further gullying would likely occur. This site would be incorporated into regular inventory and monitoring of road 10S18 and additional treatments would be specified if needed.

54281/54429 – These WIN sites document erosion occurring on FS roads 10S26 and 10S26A. Routine maintenance that would be performed in support of the Project would adequately treat these sites. The sediment is not being delivered to streams, so there would be no effect on water quality or channel shape and function.

54447 – This site documents erosion on the temporary road extension of 10S26A as it approaches and crosses Trib 23 to Big Creek (519.0011). This temporary road would be opened to provide access for Project treatments, but based on field evaluation of the crossing and the approach, this portion of the old temporary road is not suitable for re-use and would need to be realigned. A suitable location for the crossing would be identified, and the existing alignment would be stabilized by construction of waterbars and arrangement of exiting on-site materials (freshly down logs and slash) to provide groundcover and reduce concentration of surface runoff. The new alignment would be properly decommissioned after use, per BMP 2.7.

54441/54442 – These sites document road surface erosion on an established route that is not currently shown on the NFTS but is utilized for OHV events under special use permit. The route connects FS roads 10S26 and 10S75, and crosses Trib 23 to Big Creek. It is likely that it would be considered for addition to the road or motorized trail system in the future. This route crosses through the Bretz Fire area, and large scale erosional features dating to the immediate post-fire period are prevalent in the area. The route itself likely dates to post-fire management activities. Erosion on the route contributes some sediment to the stream, which would be minimized by the repair of rilling and gullying and the addition of drainage structures. However, improvement in downstream channel condition is not expected. The effects of the extensive gullying in this watershed would continue to have a far greater influence over stream conditions than this route has had.

Cumulative Effects

The cumulative effects analysis is fully described in the Soaproot Project - Baseline ERA Analysis and Detailed CWE Assessment (Gott 2012) and the results are summarized here. This alternative would result in four subdrainages exceeding the lower TOC, and would increase ERAs in eight subdrainages that are already above the lower TOC, one of which is already over the upper TOC of 14 percent. Only three of the subdrainages in the treatment area would remain under the lower TOC.

Given the analysis of direct and indirect effects, which concluded that peak flows are not expected to increase in any subdrainage and that any increases in sedimentation would be small and short term, the only areas identified with concerns for CWEs are the subdrainages along Big Creek (519.0057 and 519.0056) and Rush Creek (519.3053 and 519.3052). CWEs are already thought to be occurring in these channels, and they would integrate the effects occurring in the other subdrainages that flow into them. The Detailed Assessment (Gott 2012) concluded that the risk to beneficial uses in these subdrainages would be Low, because effects to sedimentation would be Possible (10 – 50 percent probability), and the magnitude of the consequences would be Minor (resulting in minimal, recoverable, and localized effects, in the short term). Water quality would not be degraded relative to the existing condition. Sedimentation is already a problem in these stream reaches, and V* is not expected to increase as a result of this Project. In fact, V* in Big Creek could be reduced over time as a result of road reconstruction that would reduce the hydrologic connectivity of roads.

3.4.2.3. Alternative 3

Although the silvicultural prescriptions would be different in this alternative than in alternative 2, the treatment areas and the machinery used would be the same, and therefore, the expected disturbances resulting from vegetation management would be the same as in alternative 2.

Direct and Indirect Effects

Reduction in Basal Area

The modeled reductions in basal area were the same for alternative 3 as for alternative 2. Because none of the subdrainages would have basal area reductions of at least 10 percent, there would be no effects on stream flows resulting from this alternative.

*V**

The effects on V* would be the same as described for alternative 2.

Herbicide Use in RCAs and SMZ/RMAs

There would be no herbicide use in this alternative, so there would be zero acres of RCA and SMZ/RMA treated. There would be no effects.

WIN Site Treatments

The effects of the WIN site treatments would be the same as described for alternative 2.

Cumulative Effects

The only difference in the direct and indirect effects of this alternative and those of alternative 2 is that in alternative 2 there would be some acres treated with herbicide and in this alternative there would be none. However, because herbicide use in alternative 2 would not have direct or indirect effects on water quality, it would not contribute to cumulative effects. Since all other effects of the alternatives are the same, the cumulative effects of this alternative are the same as described for alternative 2.

3.5. Aquatics[18]

3.5.1. Background and Affected Environment

The focus of the aquatics analysis was on the direct, indirect and cumulative effects of the three alternatives to listed aquatic species and their potential and occupied habitat within 14 subdrainages that encompass the Project area.

[18] The aquatics section is a summary of the Aquatics Species BE/BA prepared for the Soaproot Restoration Project. This report is herein incorporated by reference and is available in the Project planning record located at the HSRD office.

The aquatic species BA presents an analysis of effects for the Project on federally listed T, E, P, and C species (TEPC) and their habitat and is conducted to determine whether formal consultation or conference is required with the USDI USFWS, pursuant to the Endangered Species Act. The aquatic species BE documents FS programs or activities in sufficient detail to determine how an action or proposed action may affect any TEPC, or FSS species and their habitats (FSM 2670.5) to determine whether a proposed action or any of the alternatives would result in a trend toward the sensitive species becoming federally listed.

3.5.1.1. Species Account and Status

The aquatic species BA/BE (Barnes 2012) considered effects on 18 federal and state listed species and their habitats and two aquatic critical habitats within the aquatic analysis area. There were 14 TEPC, or FSS aquatic species, and two critical habitats (listed next) that either did not occur, did not have habitat within or adjacent to, or were not affected directly, indirectly, or cumulatively by the Project alternatives. These species were not addressed in detail in the aquatic species BA/BE nor was formal consultation required with the USDI USFWS for these species. The Project would have no effect on these sixteen aquatic species or their habitats or critical habitats:

Blunt-nosed leopard lizard (E), *Gambelia (=Crotaphytus) sila*

California red-legged frog (T), *Rana aurora draytonii*

California tiger salamander (T), *Ambystoma californiense*

Central valley steelhead (T), *Oncorhynchus mykiss*

Delta smelt (T), *Hypomesus transpacificus*

Giant garter snake (T), *Thamnophis gigas*

Hardhead minnow (FSS), *Mylophardon conocephalus*

Lahontan cutthroat trout (T), *Oncorhynchus (=Salmo) clarki henshawi*

Limestone salamander (FSS), *Hydromantes brunus*

Mountain yellow-legged frog (C/FSS), *Rana muscosa*

Owens tui chubb (E), *Gila bicolor snyderi*

Paiute cutthroat trout (T), *Oncorhynchus (=Salmo) clarki seleniris*

Relictual slender salamander (FSS), *Batrachoseps relictus*

Vernal Pool Fairy Shrimp and Critical Habitat (E), *Branchinecta conservation*

Vernal Pool tadpole Shrimp and Critical Habitat (E), *Lepidurus packardi*

Yosemite Toad (C/FSS), *Bufo Canorus*

Further analysis was presented in the aquatic species BA/BE (Barnes 2012) to determine the effects of the three alternatives for the Project for the following two FSS aquatic species:

Foothill yellow-legged frog (FSS), *Rana boylii*

Western pond turtle (FSS), *Clemmys marmorata* (Subspecies *marmorata* and *pallida*)

3.5.2. Environmental Consequences

There were no external issues related to aquatic species or habitat brought forward as a result of scoping for the Project. Internal issues for aquatic species or habitats recognized during Project development were resolved and resulted in some modifications to the project design. In addition, Project design criteria were developed to minimize or eliminate impacts to species and habitat and are associated with specific areas where proposed Project activities could result in negative effects on aquatic species or habitat. Determinations for the foothill yellow-legged frog and Western pond turtle were made for each alternative with the assumption that Project design criteria are implemented and SNF LRMP and ROD S&Gs are followed. When implemented, SNF LRMP and ROD S&Gs, along with BMPs would maintain or improve riparian conditions where most aquatic species habitat is found, reduce effects of Project activities and offer protection to aquatic/riparian system habitats.

The effect summary of aquatic species determinations for alternative 1, 2 and 3 for the foothill yellow-legged frog and Western pond turtle analyzed for the Project are summarized in Table 27.

Table 27. Summary of FSS aquatic species determinations for each alternative.

Species	Status	Alternative 1 (No Action)	*Alternative 2* (Proposed Action)	*Alternative 3*
Foothill yellow-legged frog	*Forest Service Sensitive*	*No Effect*	*May affect individuals, but is not likely to lead to federal listing or loss of viability*	*May affect individuals, but is not likely to lead to federal listing or loss of viability*
Western pond turtle	*Forest Service Sensitive*	*No Effect*	*May affect individuals, but is not likely to lead to federal listing or loss of viability*	*May affect individuals, but is not likely to lead to federal listing or loss of viability*

3.6. Botanical Resources[19]

3.6.1. Background and Affected Environment

The focus of the botanical resources analysis is to address the effectiveness of the alternatives in meeting the need to reduce the spread of noxious weeds and to protect sensitive botanical species within the Project area. Noxious weeds (and methods to control noxious weeds, such as herbicides) are analyzed here (and in other resources sections as applicable, such as watershed resources) as well as in the Noxious Weed Assessment for this Project (Tuitele-Lewis 2012).

The botanical species BA was written to assess the impact of the project on T&E species within or adjacent to the Project area. The analysis was conducted to determine whether formal consultation or conference is required with the USFWS pursuant to the Endangered Species Act . This BA is prepared in compliance with the requirements of FSM 2670 and provides for compliance with 50 CFR 402.12. The botanical species BE was written to assess the impact of the project on FS sensitive plants within or adjacent to the Project area. BEs are required to assess the impacts of forest projects on FSS species (FSM 2672.4). The Regional Forester approved a list of sensitive plant species for the SNF in 2006; please refer to the Soaproot Botanical resources BA/BE for reference.

[19] The botanical resources section is a summary of the Botanical Resources BE/BA prepared for the Soaproot Restoration Project. This report is herein incorporated by reference and is available in the Project planning record located at the HSRD office.

3.6.1.1. Indicators

The effects of the alternatives were evaluated using the indicators below. The indicators were selected as being the most meaningful and relevant to quantifying the effects on the landscape for assessing impacts to federally T&E or FSS plant species as well as noxious weeds.

Indicator 1: Area of T&E and FSS Plant Species and Noxious Weeds

The acres or square feet of the area of T&E or FSS species can be used as an indicator to measure the effects of the Project on these species and their protection.

The area (acres or square feet) or number of occurrences of noxious weeds is an indicator to measure effectiveness of controlling these species.

3.6.2. Environmental Consequences

3.6.2.1. Alternative 1 (no action)

Direct Effects

There are no treatments under the no action alternative and therefore, there are no direct effects related to botanical resources.

Indirect Effects

T&E & FSS Plant Species

Indirect effects from no implementation may include a heightened risk of uncontrolled wildfire in areas with abnormal amounts of downed trees and bug kill, which could negatively impact some occurrences of certain species. The most likely species to suffer negative impacts from wildfire would be carpenteria, as it inhabits both chaparral and cismontane forest systems- both of which are highly susceptible to fire disturbance. However, carpenteria responds well to light to moderate burning in the late summer (Clines 1994) and only severely burned areas and/or an early season fire would likely have long-term negative effects. It would be very difficult to ascertain the amount of areas of carpenteria that could be affected in this scenario.

Noxious Weeds

Another indirect effect of an unplanned event such as wildfire would be the increased risk of spreading of noxious weed species in the burned area. Burned areas have a temporary flush of nutrients and minerals and also have open areas free of vegetation as mentioned above, both being elements for the establishment of noxious plant species. As the area already contains Spanish broom, foxglove, and bull thistle, a large wildfire could lead to a noticeable increase in these species or others of concern.

Cumulative Effects

Cumulative effects from this alternative and other ongoing projects in the Project area would be minimal as the contribution from this alternative would essentially amount to no impact on TES species. Other projects that are scheduled to occur (and have occurred) would still have their respective effect on particular species within the Project area without any impact from this alternative.

3.6.2.2. Alternative 2 (proposed action)

Direct Effects

T&E and FSS Plant Species

Three species of concern have occurrences in the Project area. Two of these species (Yosemite bitterroot and orange annual lupine) are either located in areas proposed for treatment or are in a location within a proposed treatment (underburn) that would not receive direct effects from the treatments proposed.

One out of three occurrences of carpentaria, about 15 acres of a large 2,430 acre population, is located in proposed treatment areas (pre-commercial thinning, restoration thinning, grapple piling and pile burning). This occurrence may receive direct negative effects from accidental crushing, skidding, and piling/burning activities. Individual plants may be damaged or in particular instances extirpated through implementation of these treatments. While design criteria would mark off known occurrences of TES species, it is still possible that other plants may not be marked, especially due to the sporadic nature of carpenteria populations. It is anticipated that a maximum of 20 to 27 percent of the 15 acres may have these negative direct effects. An additional impact could result from accidental overspray of glyphosate used to control other brush species in the Project area. It is considered unlikely, as carpenteria is markedly different than the usual target species for brush control (Mariposa manzanita, mountain whitethorn, bear clover, buckbrush) but some possibility remains for this to occur on a few individual plants. Positive direct effects would entail light disturbance of established bushes (removal of some branches stimulates new growth) and any activity which would promote layering of lower branches in the soil without harming the parent plant. However, these positive effects would be small and indiscriminate and would not offset the larger risk of negative impacts on carpenteria occurrences.

Indirect Effects

T&E and FSS Species

Indirect effects would not affect Yosemite bitterroot, as the population sits well inside the rock outcrop, several hundred feet from the forest edge. As long as equipment and vehicles are not staged or run through the outcrop, indirect effects are highly unlikely.

Indirect effects are anticipated for three occurrences of orange annual lupine, most likely in the form of temporarily increased sediment delivery and increased nitrogen and nutrient deposition. These effects would be both primarily negative; sediment delivery to rock pans would allow other vegetation to gain a foothold in this specialized habitat. Increased nitrogen and nutrient deposition would also allow other species not previously capable of inhabiting these rock pans to come in and establish themselves. This would result in increased competition for resources for the affected golden annual lupine populations. Broadcast burning requires crushing of woody material before lighting. This crushing of material may have some direct negative impact on one occurrence (LUCIC-0515-056); however, only one acre out of the eleven total acres for the occurrence is located within the broadcast burn prescription. Burning of the material may also have additional direct and indirect impacts to that one acre. Some individuals may be crushed or otherwise extirpated in this occurrence but the occurrence would receive little to some impact from the treatment as it is prescribed (about 10 percent of the occurrence would receive any possible negative effects).

Indirect effects may be possible for carpenteria from road maintenance activities. Indirect impacts could occur from adjacent burns, whether they are pile burns or broadcast burns. Some of these impacts may include increased erosion, changed microclimatic conditions, altered hydrology and/or compacted soils; this would include 9.2 acres of two occurrences. Indirect negative effects for the partially contained occurrence would include soil compaction, temporary soil delivery and erosion, altered hydrology and microclimate. These effects all could inhibit new growth of adult bushes and reduce any seedling vigor. These impacts could affect at least 15 acres for this occurrence but could affect adjacent carpenteria outside of the Project area as well, up to a few hundred meters away and downslope. That would entail another 15 to 20 acres outside of the Project boundary of possible indirect effects. It must be repeated that those acres are not pure stands of the species but rather very intermittent occurrences of carpenteria within that area.

Cumulative Effects

T&E and FSS Species

The cumulative effect from the Project in this alternative for many species is negligible, as discussed in the direct and indirect effects section. The most likely cumulative impact is to carpenteria in the Project area, as Snowy Patterson Plantation Maintenance, road maintenance and various underburns all have the most likely effect to carpenteria, although underburning may have beneficial effects in certain circumstances. Veined water lichen is also thought to have some potential cumulative impacts from Dinkey South project and this project, as well as grazing that may occur in stream areas. Yosemite bitterroot has some potential for impacts from Dinkey South and North projects as well as this one; however, it is not targeted in any management activity in any project and the habitat has specific design measures to reduce any risk for this species.

3.6.2.3. Alternative 3

Direct Effects

T&E and FSS Species

Direct effects would be somewhat similar to those in alternative 2 across all TES species and their habitats, with the main exception being that the intensity of treatments and the amount of area treated would be reduced significantly due to the limitation of 12 inch dbh for thinning, elimination of the restoration thinning, reduction in mastication, tractor piling, grapple piling and the elimination of herbicide use for brush control and weed treatment. The same amount of area for carpenteria, orange annual lupine and Yosemite bitterroot would still be expected to receive possible negative effects albeit much reduced.

Indirect Effects

T&E and FSS Species

Indirect effects would be also reduced in the same fashion as per direct effects and the amount and intensity of negative indirect effects (such as erosion, soil compaction, altered hydrology, canopy cover alteration, organic matter deposition, nitrogen deposition, increased suitability for weed establishment, petroleum pollution) would decrease noticeably. However, with the remaining treatments of thinning below 12 inch dbh and some fuels prescriptions, all aforementioned TES species in alternative 2 would still face some risk of negative impacts from this alternative.

Cumulative Effects

T&E and FSS Species

Cumulative effects would be much reduced in comparison to alternative 2 but the contribution from selecting this alternative would still add some small increased possibility of negative impacts to TES plants in the Project. The same species would still be affected but their relative risk from selecting this alternative is reduced; other projects would still combine to form an overall risk to some select species (carpenteria, subalpine fireweed, veined water lichen, ascending and scalloped moonwort) over time that still has the potential to reduce the health of certain occurrences and even extirpation of individual plants.

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5.0. References

Agee , J.K.; B. Bahro; M.A. Finney; P.N. Omi; D.B. Sapsis; C.N. Skinner; J.W. van Wagtendonk; and C.P. Weatherspoon. 2000. The use of shaded fuelbreaks in landscape fire management. Forest Ecology and Management. 127:55-66.

Agee, J.K. and C.N. Skinner 2005. Basic principles for forest fuels reduction treatments. Forest Ecology and Management. 211(2005):83-96.

Andrews, P.L.; F.A. Heinsch; and L. Schelvan. 2011. How to generate and interpret fire characteristics for surface and crown fire behavior. U.S. Dept of Agriculture (USDA), Rocky Mountain Research Station, Gen. Tech. Report, RMRS-GTR-253. 40 pp.

Aubry, K. B. and C. M. Raley. 2006. Ecological characteristics of fishers (Martes Pennanti) in the southern Oregon Cascade Range. Update: July 2006. USDA, Forest Service, Pacific Northwest Research Station. Olympia, WA.

Austin, D. 2012. Air Quality Specialist Report: Soaproot Restoration Project. Unpublished report, USDA, Forest Service, Sierra National Forest, High Sierra Ranger District, District files.

Bagne, K.; K.L. Purcell; J.T. Rotenberry. 2008. Prescribed fire, snag population dynamics, and avian nest site selection. Forest Ecology and Management. 255(2008):99-105. USDA, Pacific Southwest Research Station. Fresno, CA.

Bakke, D. 2001. A review and assessment of the results of water monitoring for herbicide residues for the years 1991 to 1999. Vallejo, CA: USDA, Forest Service, Region 5.

Ballard, C. 2011. Fire Family Plus. USDA, Forest Service, Sierra National Forest, High Sierra Ranger District. District Files.

Ballard, C. 2012. Fire and Fuels Specialist Report: Soaproot Restoration Project. Unpublished report, USDA, Forest Service, Sierra National Forest, High Sierra Ranger District, District files.

Ballard, C. and B. Bahro. 2006. ProbAcre Modeling. USDA, Forest Service, Sierra National Forest, High Sierra Ranger District. District Files.

Ballard, K. 2012. Soaproot Restoration Project Economic Analysis. Unpublished report, USDA, Forest Service, Sierra National Forest, High Sierra Ranger District, District files.

Barnes, S. 2012. Aquatic Species Biological Evaluation/Biological Assessment. Unpublished reprot, USDA, Forest Service, Sierra National Forest, High Sierra Ranger District, District files.

Beche, L.A.; S.L. Stephens; and V.H. Resh. 2005. Effects of prescribed fire on a Sierra Nevada (California, USA) stream and its riparian zone. Forest Ecology and Management. 128(2005):37-59.

Behave Plus 5. 2008. Fire Behavior System, ver 5.0.3, USDA Forest Service, Rocky Mountain Research Station and Systems for Environmental Management.

Bertram, R.C. 1984. The North Kings deer herd. Calif. Dept. of Fish and Game. Wildl. Manage. Branch Admin. Rep. 203 p.

Bias, M.A. and R.J Gutiérrez. 1992. Habitat associations of California spotted owl in the central Sierra Nevada. The Journal of Wildlife Management. 56(3):584-595.

Birch, K.R. and N.K. Johnson. 1992. Stand-level wood-production costs of leaving live, mature trees at regeneration harvest in coastal Douglas-fir stands. West. Journal of Applied Forestry. 7:65-68.

Biswell, H. 1999. Prescribed burning in California wildlands vegetation management. Berkley: University of California Press.

Blakesley, J.A. 2003. Ecology of the California spotted owl: breeding dispersal and associations with forest stand characteristics in northeastern California. Dissertation, Colorado State University, Fort Collins, USA.

Bouldin, J. 1999. Twentieth-century changes in forests of the Sierra Nevada, California. Doctoral thesis, University of California, Davis.

Bowles, A.E. 1995. Responses of wildlife to noise. Chapter 8. *in* Knight and Gutzwiller, Wildlife and Recreationists Coexistence through Management and Research. pp 109-156.

Breece, C.R.; T.E. Kolb; B.G. Dickson; J.D. McMillin; and K.M. Clancy. 2008. Prescribed fire effects on bark beetle activity and tree mortality in southwestern ponderosa pine forests. Forest Ecology and Management. 255:119-128.

Brown, R.T.; J.K. Agee; and J.F. Franklin. 2004. Forest Restoration and Fire: Principles in context of place. Conservation Biology. 18(4):903-912.

Bulaon, B. and K. Kiehl. 2011. Biological Evaluation of Bark Beetle Activity in the Soaproot Project; Big Creek Watershed. Report No. SS11-11. USDA. Sonora, CA.

Busenburg, G.J. 2004. Adaptive Policy Design for the Management of Wildfire Hazards. American Behavioral Scientist. November 2004. 48(3):314-326.

Butler, B.W. and J.D. Cohen. 1998. Firefighter Safety Zones: How Big Is Big Enough? Fire Management Today. 58(1):13–16. (reprinted in 2004).

California State Public Resource Code 4291, Defensible Space, 2005 [Published October 28, 2005], Title 14 of the California Code of Regulations (14 CCR), Division 1.5, Chapter 7 Fire Protection, Subchapter 3., Article 3. http://www.fire.ca.gov/CDFBOFDB/pdfs/4291%20ISOR%2010_18_05.pdf

Caprio, A. and D. Graber. 2000. Returning fire to the mountains: Can we successfully restore the ecological role of pre-Euroamerican fire regimes to the Sierra Nevada? *In* Proceedings: Wilderness Science in a Time of Change. Rocky Mountain Research Station, RMRS-P-000. Ogden, UT.

Click, C.; J. Fiske; J. Sherlock; and R. Wescom. 1988. Alternative to herbicides - update based on 5-year herbicide use moratorium in the USDA Forest Service, Pacific Southwest Region. Proceedings of the 10th Annual Forest Vegetation Management Conference. November 1-3, 1988. Eureka, CA. 49-90.

Click, C.; J. Fiske; J. Sherlock; and R. Wescom. 1994. Alternative to herbicides in the USDA Forest Service, Pacific Southwest Region - 10-year Update. Proceedings of the 15th Annual Forest Vegetation Management Conference. January 25-27, 1994. Redding, CA. 46-60.

Cohen, J.D. 1999. Reducing the wildland fire threat to homes: Where and how much? *In* Gonzales-Caban, A.; P.N. Omi, technical coordinators. Proceedings of the Symposium on Fire Economics, Planning, and Policy: Bottom Lines; 1999 April 5-9. San Diego, CA. Gen. Tech. Rep. PSW-GTR-173. Albany, CA: USDA, Forest Service, Pacific Southwest Research Station. 189-195.

Cohen, J.D. 2008. The wildland-urban interface fire problem: A consequence of the fire exclusion paradigm. Forest History Today. Fall 2008. 20-26.

Cohen, J.D. and B.W. Butler. 1998. Modeling potential structure ignitions from flame radiation exposure with implications for wildland/urban interface fire management. *In* Proceedings of the 13th Conference on Fire and Meteorology. 1996 October 27-31. Lone, Victoria Australia. Fairfield ,WA.: International Association of Wildland Fire. 81-86.

Cohen, J.D. and R.D. Stratton. 2008. Home Destruction Examination: Grass Valley Fire, Lake Arrowhead, CA. R5-TP-026b. Available <http://www.firelab.org. Publications. Accessed: April 24, 2012.

Collins, B.M. and S.L. Stephens. 2010. Stand replacing patches within a 'mixed severity' fire regime: quantitative characterization using recent fire in a long established natural fire area. Landscape Ecology. 25:927-939.

Collins, B.M and S.L. Stephens. 2012. Fire and fuels reduction, *In:* Managing Sierra Forests. *In*: Managing Sierra Forests. Gen. Tech. Rep. PSW-GTR-237. Albany, CA: USDA, Forest Service, Pacific Southwest Research Station. 1-12.

Collins, B.M.; R. G. Everett; and S.L. Stevens. 2011a. Impacts of fire exclusion and recent managed fire on forest structure in old growth Sierra Nevada mixed conifer forests. Ecosphere. 2(4):51. 14 pp.

Collins, B.M.; S.L. Stephens; J. Maghaddas; and J.J. Battles. 2010. Challenges and approaches in planning fuel treatment across fire-excluded forested landscapes. Journal of Forestry. 8 pp.

Collins , B.M.; S.L. Stephens; G.B. Roller; and J.J. Battles. 2011b. Simulating fire and forest dynamics for a landscape fuels treatment project in the Sierra Nevada. Forest Science. 57(2) 2011: 77-88.

Corn, L.M. and K. Alexander. Forest Service Payments to Counties – Title I of the Federal Forests County Revenue, Schools, and Jobs Act of 2012: Issues for Congress, March 2012.

Cover, M.; C. May; W. Dietrich; and V. Resh. 2008. Quantitative linkages among sediment supply, streambed fine sediment, and benthic macroinvertebrates in northern California streams. Journal of North Amer. Benthol. Soc. 27(1):135-149.

Cruz, M.G. and M.E. Alexander. 2010. Assessing crown fire potential in coniferous forests of western North America: a critique of current approaches and recent simulation studies. Int. Journal of Wildland Fire. 20102, 19, 377-398.

Delaney, D.; T.G. Grubb; P. Beier; L. Pater; and M.H. Reiser. 1999. Effects of helicopter noise on Mexican Spotted Owls. Journal of Wildlife Management. 63(1):60-76.

Drumm, M.K. 1996. Fire history in mixed conifer series of the Kings River Adaptive Management Area, Sierra National Forest. M.S. Thesis. Humboldt State University, Arcata, CA.

Edinger, J.E. 2001. Waterbody hydrodynamic and water quality modeling. An introductory work book on three dimensional water body hydrodynamics and water quality modeling including modeling software. ASCE Press, Reston, VA, ISBN 0-7844-0550-6. 215 pp.

Erickson, H.E.; P. Soto; D.W. Johnson; B. Roath; C. Hunsaker. 2005. Effects of vegetation patches on soil nutrient pools and fluxes within a mixed-conifer forest. Forest Science*.* 51(3) 2005:211-220.

Federal Register, Volume 66, Number 160, Friday, August 17, 2001. Part III, USDA, Forest Service; U.S. Dept. of Interior (USDI), Bureau of Indian Affairs, Bureau of Land Management, Fish and Wildlife Service, National Park Service. Urban wildland interface communities within the vicinity of federal lands that are high risk from wildfires; Notice.

Fettig, C.J., 2012. Forest health and bark beetles, *In:* Managing Sierra Forests. Gen. Tech. Rep. PSW-GTR-237. Albany, CA: USDA, Forest Service, Pacific Southwest Research Station. 13-22.

Fettig, C.J.; J.D. McMillin; J.A. Anhold; S.M. Hamud; R.R. Borys; C.P. Dabney; and S.J. Seybold. 2006. The effects of mechanical fuel reduction treatments on the activity of bark beetles (Coleoptera: Scolytidae) infesting ponderosa pine. Forest Ecology and Management. 230: 55-68.

FireFamilyPlus and Behave Plus 5 at http://firemodels.org

Forsman, E.D.; E.C. Meslow; and H.M. Wight. 1984. Distribution and biology of the Spotted Owl in Oregon. Wildl. Monogr. 87.

Frazier, J.W.; K.B. Roby; J.A. Boberg; K. Kenfield; J.B. Reiner; D.L. Azuma; J.L. Furnish; B.P. Staab; and S.L. Grant. 2005. Stream Condition Inventory Technical Guide. USDA, Forest Service, Pacific Southwest Region – Ecosystem Conservation Staff. Vallejo, CA. 111 pp.

Fule, P.Z. 2008. Does it make sense to restore wildland fire in changing climate. Restoration Ecology. 16(4): 526-531.

Furniss, R.L. and V.M. Carolin. 1977. Western forest insects. USDA, Forest Service. Misc. Publ. 1339.

Gaines, W.L.; P.H. Singleton; and R.C. Ross. 2003. Assessing the cumulative effects of linear recreation roads and motorized trails on wildlife habitats on the Okanogan and Wenatchee National Forests. USDA, Forest Service, Pacific Northwest Research Station, Gen. Tech. Rep. PNW-GTR-586.

Gallegos, A. 2004. Big Creek Watershed Analysis. USDA Forest Service, Sierra National Forest, Open File Report. 70 pp.

Ghassemi, M.; L. Fargo; et al. 1981. Environmental fates and impacts of major forest use pesticides. EPA Contract No. 68-02-3174, U.S. Environmental Protection Agency, Office of Pesticides and Toxic Substances, Washington, D.C. 310 pp.

Graham, R.T.; S. McCaffrey; T.B. Jain. (tech. eds.). 2004. Science basis for changing forest structure to modify wildfire behavior and severity. Gen. Tech. Rep. RMRS-GTR-120. Fort Collins, CO: USDA, Forest Service, Rocky Mountain Research Station. 43 pp.

Gott, J. 2012. Soaproot Restoration Project: Baseline ERA and Detailed Cumulative Watershed Effects Analysis. Unpublished report, USDA, Forest Service, Sierra National Forest, High Sierra Ranger District, District files.

Gray, A.N.; H.S.J. Zald; R.A. Kern; and M. North. 2005. Stand conditions associated with tree regeneration in Sierran mixed-conifer forests. Forest Science. 51(3): 198-210.

Grinspoon, E. and R. Phillips. 2011. Northwest Forest Plan – The First 15 years (1994-2008): Socioeconomic Status and Trends, R6-RPM-TP-02-2011.

Gutiérrez, R.J.; J. Verner.; K.S. McKelvey; B.R. Noon; G.N. Steger; D.R. Call; W.S. LaHaye; B.B. Bingham; and J.S. Senser. 1992. Habitat relations of the California Spotted Owl. *In* Verner, J.; K.S. McKelvey; B.R. Noon; R.J. Gutiérrez; G.I. Gould; and T.W. Beck. (tech. coord.). The California Spotted Owl: a technical assessment of its current status; 79-98. Gen. Tech. Rep. PSW-GTR-133. Albany CA: USDA, Forest Service.

Hanson, C. 2010. The myth of "catastrophic" wildfire: a new ecological paradigm of forest health. John Muir Project Tech. Rep. in peer review. 29 pp.

Harrod, R.J.; D.W. Peterson; N.A. Povak; and E.K. Dodson. 2009. Thinning and prescribed fire effects on overstory tree and snag structure in dry coniferous forest of the interior Pacific Northwest. Forest Ecology and Management. 258:712–721.

Hayward, L. and S. Wasser. 2008. Prelimary results on the effects of acute off-highway vehicle exposure on the Northern spotted owl (Strix occidentalis caurina). Preliminary report to the USDA Forest Service, prepared by the University of Washington, Center for Conservation Biology.

Hicke, J.A.; M.C. Johnson; J.L. Hayes; and H.K. Preisler. 2012. Effects of bark beetle-caused mortality on wildfire. Forest Ecology and Management. 271(2012): 81-90.

Hosten, P.E.; H. Whitridge; and M. Broyles. 2007. Diet overlap and social interactions among cattle, horses, deer, and elk in the Cascade-Sisyiyou National Monument, southwest Oregon. USDI, Bureau of Land Management, Medford District. http://soda.sou.edu/bioregion.html

Innes, J.; M. North; and N. Williamson. 2006 Effects of thinning and prescribed fire restoration treatments on woody debris and snag dynamics in a Sierran old-growth mixed conifer forest. Canadian Journal of Forest Research. 36: 3183-3193.

Jain, T.B. and R.T. Graham. 2004. Is forest structure related to fire severity? Yes, no, and maybe: methods and insights in quantifying the answer. USDA Forest Service Proceedings RMRS-P-34. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station. pp 49-63.

Johnson, M.C.; M.C. Kennedy; and D.L.Peterson. 2011. Simulating fuel treatment effects in dry forest of the western United States: testing the principles of a fire safe forest. Canadian Journal of Forest Research. 41(2011): 1018-1030.

Jordan, M.J. 2007. Fisher ecology in the Sierra National Forest, California. Ph.D. Dissertation. University of California, Berkely. 122 pp.

Kappesser, G.B. 2002. A riffle stability index to evaluate sediment loading to streams. Journal of the American Water Resources Association. 38(4): 1069-1081.

Kauffman, J.B. and R.E. Martin. 1990. Sprouting shrub response to different seasons and fuel consumption levels of prescribed fire in Sierra Nevada mixed conifer ecosystems. Forest Science. 36:748-764.

Keane, R.E.; S.A. Drury; E.C. Karau; P.F. Hessburg; and K.M. Reynolds. 2010. A method for mapping fire hazard and risk across multiple scales and its application in fire management. Economic Modeling. 221(2010):2-18.

Keeley, J.E. 2001. Fire and invasive species in Mediterranean-climate ecosystems of California. pp 81-94 *In* K.E. Galley and T.P. Wilson, editors. Proceedings of the invasive species work shop: The role of fire in the control and spread of invasive species. Misc. Publ. No. ll. Tall Timbers Research Station, Tallahassee, Florida.

Keeley J.E. and H.L. Stephenson. 2000. Restoring fire regimes to the Sierra Nevada in an era of global climate change. *In:* Proceedings of the wilderness science in a time of change conference. (Eds DN Cole, SF McCool,WT Borrie, J McLoughlin) pp 255–265. USDA, Forest Service, Rocky Mountain Research Station, RMRS-P-15, Vol. 5. (Ogden, UT).

Keeley, JE.; G.H. Aplet; N.L. Christensen; S.G. Conrad; E.A. Johnson; P.N. Omi; D.L. Petersen; and T.E. Swetnam. 2009. Ecological foundations for fire management in North American forest and shrubland ecosystems.Gen. Tech. Rep. PNW-GTR-779. Portland, OR: USDA, Forest Service, Pacific Northwest Research Station. 92 pp.

Keyser, C.E.; comp. 2008 (revised March 11, 2011). Western Sierra Nevada (WS) Variant Overview – Forest Vegetation Simulator. Internal Rep. Fort Collins, CO: USDA, Forest Service, Forest Management Service Center. 43 pp.

Kolb, T.E.; J.K. Agee; P.Z. Fulé; N.G. McDowell; K. Pearson; A. Sala; and R.H. Waring. 2007. Perpetuating old ponderosa pine. Forest Ecology and Management. 249:141-157.

Kolb, T.E.; K.M. Holmberg; M.R. Wagner; and J.E. Stone. 1998. Regulation of ponderosa pine foliar physiology and insect resistance mechanisms by basal area treatments. Tree Physiology. 18(6): 375-381.

LaHaye, W.S.; R.J. Gutierrez; D.R. Call. 1992. Nest and roost site selection in an insular population of California spotted owls. Unpublished draft supplied by authors; 17p.

Larson, M.M. and G.H. Schubert. 1969. Root competition between ponderosa pine seedlings and grass. USDA Forest Service, Research Paper RM-RP-54. Fort Collins, CO: USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station; 12 p.

Laymon, S.A. 1988. The ecology of the spotted owl in the central Sierra Nevada, California. Dissertation, University of California, Berkely. 285 pp.

Lilieholm, R.J.; L.S. Davis; R.C. Heald; and S.P. Holmen. 1990. Effects of single tree selection harvests on stand structure, species composition and understory tree growth in a Sierra mixed conifer forest. Western Journal of Applied Forestry. 5(2): 43-47.

Lisle, T.E. and S. Hilton. 1999. Fine bed material in pools of natural gravel bed channels. Water Resources Research. 35(4):1291-1304.

Maloney, P.E. and D.M. Rizzo. 2002. Pathogens and insects in a pristine forest ecosystem: the Sierra San Pedro Martir, Baja, Mexico. Canadian Journal of Forestry Research. 32: 448–457.

Marsh, S. 2012. Cultural Resource Management of the Soaproot Restoration Project: Archaeological Reconnaissance Report R2012051552001. Unpublished report, USDA, Forest Service, Sierra National Forest, High Sierra Ranger District, District files.

Martinson E.J. and P.N. Omi. 2003. Performance of fuels treatments subjected to wildfires. USDA Forest Service Proceedings RMRS-P-29. pp 7-14.

Mason, C.L., et al., Investment in fuel removals to avoid forest fires result in substantial benefits. Journal of Forestry. Jan/Feb 2006: 27-31.

Mazzoni, A.K. 2002. Habitat use by fishers (Martes pennanti) in the southern Sierra Nevada, California. M.S. thesis, California State University, Fresno. Fresno, CA. 52 pp.

McDonald, P.M. 1976. Inhibiting effects of ponderosa pine seed trees on seedling growth. Journal of Forestry. 74(4): 220-224.

McDonald, P.M. 1986 .Grasses in Young Conifer Plantations-Hindrance and Help. Northwest Science. 60(4).

McDonald, P.M. and G.O. Fiddler. 1989. Competing vegetation in ponderosa pine plantations: ecology and control. Gen. Tech. Rep. PSW-GTR-113. Albany, CA: USDA, Forest Service, Pacific Southwest Forest and Range Experiment Station. 26 p.

McDonald, P.M. and G.O. Fiddler. 1990. Ponderosa pine seedlings and competing vegetation: ecology, growth, and cost. Research Paper. PSW-RP-199. Albany, CA: USDA, Forest Service, Pacific Southwest Forest and Range Experiment Station. 10 p.

McDonald, P.M. and G.O. Fiddler. 1995. Development of a mixed-shrub-ponderosa pine community in a natural and treated condition. Research Paper. PSW-RP-224. Albany, CA: USDA, Forest Service, Pacific Southwest Forest and Range Experiment Station. 19 p.

McDonald, P.M. and G.O. Fiddler. 1997. Mechanical and chemical release in a 12-year-old ponderosa pine plantation. Research Paper. PSW-RP-232. USDA, Forest Service, Pacific Southwest Forest and Range Experiment Station. 12 p.

McDonald, P.M. and G.O. Fiddler. 1997b. Timing and duration of release treatments affect vegetation development in a young California red fir plantation. Gen. Tech. Rep. PSW-GTR-233 Albany, CA: Pacific Southwest Research Station, USDA, Forest Service. 14 p.

McDonald, P.M. and G.O. Fiddler. 2001. Timing and duration of release treatments affect vegetation development in a young California white fir plantation. Research Paper. PSW-RP-246. Albany, CA: USDA, Forest Service, Pacific Southwest Forest and Range Experiment Station. 14 p.

McDonald, P.M.; G.O. Fiddler; and D.A. Potter. 2004. Ecology and manipulation of bearclover (Chamaebatia foliolosa) in northern and central California: The status of our knowledge. Gen. Tech. Rep. PSW-GTR-190. Albany, CA: USDA, Forest Service, Pacific Southwest Forest and Range Experiment Station. 26 p.

McDonald, P.M. and P.E. Reynolds. 1999. Plant community development after 28 years in small group-selection openings. Research Paper. PSW-RP-241. Albany, CA: USDA, Forest Service, Pacific Southwest Forest and Range Experiment Station. 17 p.

McDonald, P.M. and W.W. Oliver. 1983. Woody shrubs retard the growth of ponderosa pine seedlings and saplings, p.65-89. In Proceedings, 5th Annual Forest Vegetation Management Conf., Nov 2-3, 1983, Redding, CA. 162 p.

Mchugh, C.W.; T.E. Kolb; and J.L. Wilson. 2003. Bark beetle attacks on ponderosa pine following fire in Northern Arizona. Population Ecology. 32(3): 510-522.

McKelvey, K.S.; C.N. Skinner; C. Chang; D.C. Erman; S.J. Husari; D.J. Parsons; J.W. van Wagtendonk; and C.P. Weatherspoon. 1996. An overview of fire in the Sierra Nevada. In: Sierra Nevada Ecosystem Project: Final report to Congress, Volume II, Chapter 37. Univ. Calif., Davis, Wildland Resources Center Rep. 37. 1033-1040; 1528 p.

McKenzie, D.; Z. Gedalof; D.L. Petersen; and P. Motes. 2004. Climate change, wildfire and conservation. Conservation Biology. 18(4): 890-902.

McKenzie, D. and M.C. Kennedy. 2011. Scaling law and complexity in fire regimes, in the Landscape Ecology of Fire. Springer Press. 27-49.

Meyer, M. and H. Safford. 2010. A summary of current trends and probable future trends in climate and climate-driven process in the Sierra National Forest and the neighboring Sierra Nevada. Unpublished, USDA, Forest Service. 20 pp.

Millar, C.I. and W.B. Woolfenden. 1999. The role of climate change in interpreting historical variability. Ecological Applications. 9:1207–1216.

Millar, C.I. and W.B. Woolfenden. 1999. Sierra Nevada forests: Where did they come from? Where are they going? What does it mean? pp 206-236 *In* R.McCabe and S. Loos (eds.), Natural Resource Management: Perceptions and Realities. Transactions of the 64th North American Wildlife and Natural Resource Conference. March 26-30, 1999. San Francisco-Burlingame. Wildlife Management Institute, Washington D.C.

Miller, J.M. and F.P. Keen. 1960. Biology and control of the western pine beetle. Misc. Publ. 800. Washington, DC: USDA. 381 pp.

Miller, J.D.; E.E. Knapp; C.H. Key; C.N. Skinner; C.J. Isbell; R.M. Creasy; and J.W. Sherlock. 2009a. Calibration and validation of the relative differenced Normalized Burn Ratio (RdNBR) to three measures of fire severity in the Sierra Nevada and Klamath Mountains, California, USA. Remote Sensing of Environment. 113:645–656.

Miller, J.D.; H.D. Safford; M. Crimmins; and A.E. Thode. 2008. Quantitative evidence for increasing forest fire severity in the Sierra Nevada and southern Cascade Mountains, California and Nevada, USA. Ecosystems. 12(1): 16-32.

Miller, J.D.; H.D. Safford; M.A. Crimmins; and A.E. Thode. 2009b. Quantitative evidence for increasing forest fire severity in the Sierra Nevada and southern Cascade Mountains, California and Nevada, USA. Ecosystems. 12:16–32.

Miller, J.D.; C.N. Skinner; H.D. Safford; E.E. Knapp; and C.M. Ramirez. 2012. Trends and causes of severity, size and number of fires in northwestern California, USA. Ecological Applications. 22(1) 2012: 184-203.

Mitchell, R.G. and R.E. Martin. 1980. Fire and insects in pine culture of the Pacific Northwest. *In* Proceedings Sixth Conference on Fire and Forest Meteorology, April 22-24.

Moyle, P.B. 2002. Inland Fishes of California. Revised and Expanded, 2nd edn. University of California Press: Berkeley, CA.

Mutch, R.W. and W. Cook. 1996. Restoring fire to ecosystems: methods vary with land management goals. *In*: Gen. Tech. Rep. INT-GTR-341. Proceedings of the use of fire in forest restoration. Ogden, UT: Intermountain Research Station, USDA, Forest Service.

Naney, R.H.; L.L. Finley; E.C. Lofroth; P.J. Happe; A.L. Krause; et al. 2012 Conservation of fishers (Martes pennanti) in south-central British Columbia, Western Washington, Western Oregon, and California – Volume III: Threat Assessment. USDA, Bureau of Land Management, Denver Colorado, USA.

National Wildfire Coordination Group. 2004. NWCG Handbook 3, PMS 410-1 NFES 0065. National Interagency Fire Center.

Norris, Vol. 1993. The use of buffer zones to protect water quality: a review. Water Resources Management. 7:257-272.

North, M.P.; J. Chen; B. Oakley; B. Song; M. Rudnicki; A. Gray; and J. Innes. 2004. Forest stand structure and pattern of old-growth western hemlock/Douglas-fir and mixed-conifer forests. Forest Science. 50(3): pp 299-311.

North, M.P.; M. Hurteau; R. Fiegener; and M. Barbour. 2005. Influence of fire and El Ninõ on tree recruitment varies by species in Sierran mixed conifer. Forest Science. 51(3): 187-197.

North, M.P.; J. Innes; and H. Zald. 2007. Comparison of thinning and prescribed fire restoration treatments to Sierran mixed-conifer historic conditions. Canadian Journal of Forest Resources. 37:331-342.

North, M.,P. Stine, K. O'Hara, W. Zielinski, and S. Stephens. 2009. *An ecosystem management strategy for Sierran mixed-conifer forests.* General Technical Report PSW-GTR-220. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station.

North, M.P., ed. 2012**.** Managing Sierra Nevada forests. Gen. Tech. Rep. PSW-GTR-237. Albany, CA: USDA, Forest Service, Pacific Southwest Research Station. 184 pp.

Noss, R.F.; J. Franklin; W.L. Baker; T. Schoennagel; and P.B. Moyle. 2006. Managing fire prone forests in the western United States. Frontiers in Ecology and Environment. 4(9): 481-487.

Odion, D. and C.T. Hanson. 2006. Fire severity in conifer forests of the Sierra Nevada, California. Ecosystems. 9:1177-1189

Oliver, C.D. 1995. Uneven-aged stand Dynamics. In: O'Hara, K.L., ed. Uneven- aged management: opportunities, constraints and methodologies. MFCES Misce. Pub. No. 56. Missoula, MT: School of Forestry, University of Montana. pp 82-93.

Oliver, C.D. and B.C. Larson. 1996. Forest Stand Dynamics. John Wiley and Sons, New York, NY.

Oliver, W.W. 1979. Fifteen-year growth patterns after thinning a ponderosa-Jeffery pine plantation in northeastern, California. Research paper. PSW-RP-141. Berkeley, CA: USDA, Forest Service, Pacific Southwest Forest and Range Experiment Station. 10 p.

Oliver, W.W. 1990. Spacing and shrub competition influence 20-year development of planted ponderosa pine. Western Journal of Applied Forestry. 5(3): 79-82.

Oliver, W.W. and R.F. Powers. 1978. Growth models for ponderosa pine: I. Yield of unthinned plantations in northern California. Research Paper PSW-133. Berkeley CA: Pacific Southwest Forest and Range Experiment Station, USDA, Forest Service. 21p.

Oliver, W.W. and F. Uzoh. 1997. Maximum stand densities of ponderosa pine and red and white fir in Northern California. In 18th annual Forest Vegetation Management Conference. Sacramento, CA.

Oliver, W.W and F. Uzoh. 2002. Little response of true fir saplings to understory shrub removal. Western Journal Of Applied Forestry. 17(1): 5-8.

Omi, P.N and E.J. Martinson. 2002. Final report: Effects of fuels treatments on wildfire severity. Western Forest Fire Research Center, Colorado State University. Submitted to Joint Fire Science Program Governing Board.

Paragi, T.F.; W.N. Johnson; D.D. Katrik; and A.J. Magoun. 1996. Marten selection of postfire series in the Alaskan taiga. Can. J. Zool. 74.(12): 2226-2237.

Parker, T.J.; K.M. Clancy; and R.L. Mathiasen. 2006. Interactions among fire, insects and pathogens in coniferous forests of the interior western United States and Canada. Agricultural and Forest Entomology. 8: 167-169.

Parks, C.G.; E.L. Bull; R.O. Tinnin; J.F. Shepherd; and A.K. Blumton. 1999. Wildlife use of dwarf mistletoe brooms in Douglas-fir in northeast Oregon. Western Journal of Applied Forestry 14:100-105.

Passovoy, M.D. and P.Z. Fulè. 2006. Snag and wody debris dynamics following severe wildfires in northern Arizona ponderosa pine forests. Forest Ecology and Management. 223(1)-3: 237-246

Phillips, C. 1998. Fire-return intervals in mixed-conifer forests of the Kings River Sustainable Forest Ecosystems Project Area. Unpublished internal report.

Poage, N.J. and J.C. Tappeiner, II. 2002. Long-term patterns of diameter and basal area growth of old-growth Douglas-fir trees in western Oregon. Canadian Journal of Forest Research. 32: 1232-1243.

Pollet, J. and P.N. Omi. 2002. Effect of thinning and prescribed burning on crown fire severity in ponderosa pine forest. International Journal of Wildland Fire. 11(1):1–10.

Powers, R.F.; F.G. Sanchez; D.A. Scott; and D. Page-Dumroese. 2004. The North American long-term soil productivity experiment: coast-to-coast findings from the first decade. USDA Forest Service Proceedings RMRS-P-34. Fort Collins, CO: USDA, Forest Service, Rocky Mountain Research Station. 16 p.

Public Law 108-148. (2003, December 3). Healthy Forests Restoration Act of 2003. 117 Stat. 1887.

Public Law 111-11. (2009, March 30). Omnibus Public Land Management Act of 2009. 123 Stat. 991.

Reed, W.J. 2006. A note on fire frequency concepts and definitions. Canadian Journal of Forest Research 36:1884-1888.

Reinhardt, E.; N.L. Crookston. (Tech. Ed.s). 2003. The Fire and Fuels Extension to the Forest Vegetation Simulator. Gen. Tech. Rep. RMRS-GTR-116. Ogden, UT: USDA, Forest Service, Rocky Mountain Research Station. 209 pp.

Rothermel, R.C. 1983. How to predict the Spread and Intensity of Forest and Range Fires. USDA Forest Service, National Wildfire Coordinating Group, USDA, Forest Service and USDI. PMS-436-1.

Running, S.W. 2006. Is global warming causing more, larger wildfires? Science. 313: 927-928.

Safford, H.D.; D.A. Schmidt; and C.H. Carlson. 2009. Effects of fuels treatments on fire severity in an area of wildland-urban interface, Angora Fire, Lake Tahoe Basin, California. Forest Ecology and Management. 258 (2009): 773-787.

Safford, H.D.; K. van de Water; and D. Schmidt. 2011. California Fire Return Interval Departure (FRID) map, 2010 version. USDA, Forest Service, Pacific Southwest Region and The Nature Conservancy-California. http://www.fs.fed.us/r5/rsl/clearinghouse/r5gis/frid/

Safford H.D. and B.M. Collins. 2012. Personal Conversation. High Sierra Ranger District Office, May 26, 2012 as part of Southern Sierra Prescried Fire and Smoke Symposium (field day).

Safford, H.D.; M.P. North; and M.D. Meyer. 2012. Climate change and the relevance of historic forest conditions, *In:* Managing Sierra Forests. Gen. Tech. Rep. PSW-GTR-237. Albany, CA: USDA, Forest Service, Pacific Southwest Research Station. pp 23-45.

Sanchez, C. 2012. Soaproot Project – Visual Resources (Scenery) Sierra National Forest. Unpublished report, USDA, Forest Service, Sierra National Forest, High Sierra Ranger District, District files.

Sanchez, J. 2012. Management Indictor Species Report: Soaproot Restoration Project. Unpublished report, USDA, Forest Service, Sierra National Forest, High Sierra Ranger District, District files.

Savage, M. 1994. Anthropogenic and natural disturbance and patterns of mortality in a mixed conifer forest in California. Canadian Journal of Forest Research. 24: 1149-1159.

Scheller, R.C.; W.D. Spenser; H. Rustigian-Romsos; et al. 2011. Using stochastic simulation to evaluate competing risks on wildfires and fuels management on isolated forest carnivores. Landscape Ecology 26:1491-1504.

Schoennagel, T.; T.T. Veblen; and W.H. Romme. 2004. The interaction of fire, fuels and climate across Rocky Mountain forests. BioScience. 54(7): 661-676. PDF.

Scholl, A.E. and A.H. Taylor. 2010. Fire regimes, forest change, and self-organization in an old-growth mixed-conifer forest, Yosemite National Park, USA. Ecological Applications. 20(2):362-380.

Seamans, M.E. 2005. Population biology of the California Spotted Owl in the Central Sierra Nevada. Ph.D. Dissertation. University of Minnesota. St. Paul, Minnesota.

Seglund, A.E. 1995. The use of resting sites by the Pacific fisher. Thesis, Humboldt State University, Arcata, California, USA.

Self, S.E. and S.J. Kerns. 2001. Pacific fisher use of a managed forest landscape in northern California. Sierra Pacific Industries, Redding, California. USA.

Sherlock, J.W. 2007. Intergrating stand density management with fuel reduction. *In*: Powers, R. F., tech. ed. Restoring fire adapted ecosystems: proceeding of the 2005 national silviculture workshop. Gen. Tech. Rep. PSW-GTR-203. Albany, CA: Pacific Southwest Region, USDA, Forest Service. pp 55-66.

Sorini-Wilson, K. 2012. Terrestrial Wildlife Biological Assessment/Biological Evaluation: Soaproot Restoration Project. Unpublished report, USDA, Forest Service, Sierra National Forest, High Sierra Ranger District, District files.

Spencer, W.D.; H.L. Rustigian; R.M. Scheller; and J. Strittholt. 2007. Southern Sierra Nevada Fisher Baseline Assessment Final Report: Baseline evaluation of fisher habitat and population status in the southern Sierra Nevada. Unpublished report prepared for USDA Forest Service, Pacific Southwest Region. December 2007. 42 pp.

Spencer, W.D.; H.L. Rustigian; R.M. Scheller; A. Syphard; J. Strittholt; and B. Ward. 2008. Baseline evaluation of fisher habitat and population status, and effects of fires and fuels management on fishers in the southern Sierra Nevada. Unpublished report prepared for USDA Forest Service, Pacific Southwest Region. June 2008. 133 pp + appendices.

Spies, T.A.; J.D. Miller; J.B. Buchanan; et al. 2009. Underestimating risks to the northern spotted owl in fire-prone forests: Response to Hanson et al. Conservation Biology. 24(1): 330-333.

Stednick, J.D. 2000. Timber Management. Chapter 10 in : Dissmeyer, George E., editor. Drinking water from forests and grasslands, a synthesis of the scientific literature. SRS-GTR-39. Southern Research Station, Ashville, NC. Available via: http://www.srs.fs.fed.us/pubs/gtr/gtr_srs039/gtr_srs039-part_3.pdf

Stephens, S.L. 2005. Forest fire causes and extent on United States Forest Service lands. Berkeley, Ca.: Division of Ecosystem Science, Department of Environmental Science, Policy, and Management, University of California. International Journal of Wildland Fire. 14(2005):213–222.

Stephens, S.L. and J.J. Moghaddas. 2005. Silvicultural and reserve impacts on potential fire behavior and forest conservation: Twenty-five years of experience from Sierra Nevada mixed conifer forests. Biological Conservation.

Stephens, S.L.; R.E. Martin; and N.E. Clinton. 2007. Prehistoric fire area and emissions from California's forests, woodlands, shrublands, and grasslands. Forest Ecolo. Manag. 251:205-216.

Stephens, S.L.; J.J. Moghaddas; C. Ediminster; et al. 2009. Fire treatment effects on vegetation structure, fuels, and potential fire severity in six western U.S. forests. Ecological Applications.19: 305–320.

Stephens, S.L.; C.I. Millar; and B.M. Collins. 2010. Operational approaches to managing forests of the futurein Mediterranean regions within a context of changing climates. Environmental Research Letters. 5 (2012) 024003 (9pp).

Stephenson, N.L. 1999. Reference conditions for giant sequoia forest restoration: structure, process, and precision. Ecological Applications. 9:1253-1265.

Strom, B.A. and P.Z. Fule'. 2007. Pre-wildfire fuel treatments affect long-term ponderosa pine forest dynamics. Int. Journal of Wildland Fire. 16 (2007): 128-138.

Sutton, S. 2011. Wildlife biologist for Pacific Southwest Research Station. Personal communication regarding nesting status of California spotted owls within demographic owl study area. October 7, 2011.

Tane, Z. 2012. Vegetation and Silvicultural Specialist Report: Soaproot Restoration Project. Unpublished report, USDA, Forest Service, Sierra National Forest, High Sierra Ranger District, District files.

Tappeiner, J.C.; D. Huffman; D. Marshall; T.A. Spies; and J.D. Bailey. 1997. Density, ages, and growth rates in old-growth and young-growth forests in coastal Oregon. Canadian Journal of Forest Research. 27: 638-648.

Tappeiner, J.C. and S.R. Radosevich. 1982. Effect of Bearmat (chamaebatia foliolosa) on soil moisture and ponderosa pine growth. Weed Science. 30: 98-101.

Taylor, A H. 2004. Identifying forest reference conditions on early cut-over lands, Lake Tahoe Basin, USA. Ecological Applications. 14(6): 1903-1920.

Thode, A.E.; J.W. van Wagtendonk; J.D. Miller; and J.F. Quinn. 2011. Quantifying the fire regime distributions for severity in Yosemite National Park, California, USA. International Journal of Wildland Fire 2011. 20:223-239.

Troendle, C.A.; L.H. MacDonald; and C.H. Luce. 2010. Fuels management and water yield. Chapter 7 *In*: Elliot, W. J., I. S. Miller, and L. Audin, eds., Cumulative watershed effects of fule management in the western United States. RMRS-GTR-231, Fort Colloins, CO. 299p.

Truex, R. L. 2006. USFS personal communication. Clarification on fisher information.

Truex, R. L. 2009. USFS personal communication. Clarification on fisher information.

Tuitele-Lewis, J. 2012. Botanical Species Biological Assessement/Biological Evaluation: Soaproot Restoration Project. Unpublished report, USDA, Forest Service, Sierra National Forest, High Sierra Ranger District, District files.

Twery M. and K.W. Gottschalk. 1996. Forest health: another fuzzy concept. J. For. 94 (8) (1996): 20

USDA Forest Service. 1974. National Forest Landscape Management Volume 2, Chapter 1: The Visual Management System. Agriculture Handbook 462. USDA, Forest Service.

USDA Forest Service. 1989. Forest Service Handbook 2509.22, Soil and Water Conservation Practices Handbook, Sierra National Forest Supplement No. 1. 13 pp.

USDA Forest Service. 1992. Sierra National Forest land and resource management plan. USDA, Forest Service, Pacific Southwest Region, Sierra National Forest. September 24.

USDA Forest Service. 1995. Sierra National Forest land and resource management plan amendment. Forest Service, Sierra National Forest.

USDA Forest Service. 2001. Sierra Nevada Forest Plan Amendment, Final Supplemental Environmental Impact Statement, Record of Decision. Vallejo, CA. Pacific Southwest Region, USDA Forest Service. 55 pp + appendices.

USDA Forest Service. 2001. First Amended Regional Programmatic Agreement Among the U.S.D.A. Forest Service, Pacific Southwest Region, California State Historic Preservation Officer, and Advisory Council on Historic Preservation Regarding the Process for Compliance with Section 106 of the National Historic Preservation Act for Undertakings on the National Forests of the Pacific Southwest Region (Regional PA).

USDA Forest Service. 2004. Sierra Nevada Forest Plan Amendment Record of Decision and Final Supplemental Environmental Impact Statement. USDA, Forest Service, Pacific Southwest Region. Vallejo, CA 492pp + 72 pp (ROD). January 7.

USDA Forest Service. 2006. Kings River Project Final Environmental Impact Statement.

USDA Forest Service. 2008. Kings River Project Draft Supplemental Environmental Impact Statement.

USDA Forest Service. 2008. Baseline evaluation of fisher habitat and population status, and effects of fires and fuels management on fishers in the southern Sierra Nevada. Unpublished report prepared for USDA Forest Service, Pacific Southwest Region. June 2008. 133 pp + appendices.

USDA Forest Service. 2009. Forest Service Handbook 7709.59, Chapter. 40. Road System Operations and Maintenance Handbook, 2009.

USDA Forest Service. 2010. Forest Service Manual 2500 – Watershed and Air Management, Chapter 2550 – Soil Management. FSM National Headquarters (WO), Washington, D.C.

USDA Forest Service. 2010a. Sierra Nevada Forests Bioregional Management Indicator Species (MIS) Report: Life history and analysis of Management Indicator Species of the 10 Sierra Nevada National Forests: Eldorado, Inyo, Lassen, Modoc, Plumas, Sequoia, Sierra, Stanislaus, and Tahoe National Forests and the Lake Tahoe Basin Management Unit. Pacific Southwest Region, Vallejo, CA. December 2010. 132pp.

USDA Forest Service. 2011a. Biological evaluation of bark beetle activity in Soaproot project, Big Creek watershed. State and Private Forestry, Forest Health Protection, Southern Sierra Shared Service Area. Report No. SS11-11. 9 pp.

USDA Forest Service. 2011b. Western bark beetle strategy for human safety, recovery and resiliency. Unpublished. 24 pp.

USDI Fish and Wildlife Service. 2004. Endangered and Threatened Wildlife and Plants; 12-month Finding for a Petition to List the West Coast Distinct Population Segment of the Fisher (Martes pennant*);* Proposed Rule. Federal Register 69:18770-18792.

USDI Fish and Wildlife Service. 2006. 12-month Finding for a Petition to List the California Spotted Owl (Strix occidentalis occidentalis) as Threatened or Endangered. Federal Register 71 (100): 29886-29908.

Verner, J.K.; S. McKelvey; B.R. Noon; R.J. Gutierrez; G.I. Gould, Jr.; and T. W. Beck. 1992. The California spotted owl: a technical assessment of its current status. Gen. Tech. Rep. PSW-GTR-133. Albany, CA: Pacific Southwest Research Station, USDA, Forest Service. 285pp.

Wallbrink, P. J. and J. Croke. 2002. A combined rainfall simulator and tracer approach to assess the role of Best Management Practicies in minimizing sediment redistribution and loss in forests after harvesting. Forest Ecology and Management. 170:217-232.

Wallin, K.F.; T.E. Kolb; K.R. Skov; and M.R. Wagner. 2003. Effects of crown scorch on ponderosa pine resistance to bark beetles in Northern Arizona. Environmental Entomology. 32(3): 652-661.

Wasser, S.K.; K. Bevis; G. King; E. Hanson. 1997. Noninvasive physiological measures of disturbance in the northern spotted owl. Conservation Biology. 11(4): 1019-1022.

Weatherspoon, C.P. and C.N. Skinner. 1995. An assessment of factors associated with damage to tree crowns from the 1987 wildfires in Northern California. Forest Science. 41(3):430–451.

Westerling A.L.; H.G. Hidlago; D.R. Cayan; and T.W. Swetnam. 2006. Warming and earlier spring increase Western U.S. forest wildfire activity. Science. 313:940-943.

Yaeger, J.S. 2005. Habitat at fisher resting sites in the Klamath Province of northern California. Thesis. Humboldt State Universit,y, Arcata, California. USA.

York, R.A.; J.J. Battles; and R.C. Heald. 2004. Gap based silviculture in a Sierran mixed conifer forest: Effects of gap size on early survival and 7-year seedling growth. Gen. Tech. Rep. PSW-GTR-203. Albany, CA: Pacific Southwest Research Station, USDA Forest Service. 11 pp.

Zabel, C.J.; G.N. Steger; K.S. McKelvey; G.P. Eberlein; B.R. Noon; and J. Verner. 1992. Home-range size and habitat-use patterns of California spotted owls in the Sierra Nevada. U.S. For. Serv. Gen. Tech.Rep. No. PSW-GTR-133. pp 149-164.

Zielinski, W.J.; R.H. Barrett; and R.L. Truex. 1997. Southern Sierra Nevada fishers and marten study: Progress Report IV. USDA, Forest Service, Pacific Southwest Research Station, Redwood Sciences Laboratory, Arcata, CA. 37p.

Zielinski, W.J.; R.L. Truex; G.A. Schmidt; F.V. Schlexer; K.N. Schmidt; and R.H. Barrett. 2004. Home range characteristics of fishers in California. Journal of Mammalogy. 85: 649-657.

Zielinski, W.J.; R.L. Truex; G.A. Schmidt; F.V. Schlexer; K.N. Schmidt; and R.H. Barrett. 2004a. Resting habitat selection by fishers in California. Journal of Wildlife Management. 68: 475-492.